Karlsruhe Institute of Technology

CEDIM

RESEARCH REPORT 2015 - 2016

Content

Imprint

CEDIM Research Report 2015 - 2016

Editors: **Prof. Dr. Michael Kunz**
Dr. André Dittrich

tech. Assistant: **Johannes Hilpert**

DOI: **10.5445/IR/1000069933**

State: June 2017

Cover picture: Devastated street in Braunsbach, Germany after flood events end of May and beginning of June 2016. Image by Dr. Andreas Kron Captured 7 June 2016

Printed by: Systemedia GmbH, Wurmberg

CEDIM

Center for Disaster Management and
Risk Reduction Technology
Hermann-von-Helmholtz-Platz 1
76344 Eggenstein-Leopoldshafen, Germany
info@cedim.de

Preface

The Center for Disaster Management and Risk Reduction Technology (CEDIM) is an interdisciplinary research institution in the field of disaster management. After 10 years of successful cooperation with the Deutsches GeoForschungsZentrum Potsdam (GFZ), the Karlsruhe Institute of Technology (KIT) became solely responsible for CEDIM in January 2016. At present, 16 KIT institutes participate in CEDIM. This report provides an overview of the research work and activities of CEDIM during 2015 and 2016.

For several years, CEDIM's research has focused on Forensic Disaster Analyses (FDA)[1] in near-real-time. The objectives of this new research are to assess a disaster directly after its occurrence, analyse its effects, track its temporal development, and identify the factors most relevant to its implications. In the course of a CEDIM FDA-Task Force Activity, reports with different foci are written contemporaneously, i.e., a few days to weeks after the disaster occurs. In some cases, specific field studies on site complement these analyses.

Various CEDIM FDA activities have been performed in the last two years, and are described in detail in Chapter I. A team of researchers analysed the effects on various regions of the severe earthquake in Nepal on 25 August 2015, as well as the intensity and frequency of the aftershocks. During three field studies (June and November 2015; April 2016), different surveys were conducted on site to shed light on the situation in the emergency shelters, establish criteria for an evacuation, and evaluate existing information gaps for the public. On this basis, a conceptual model was constructed to assess the vulnerability of critical infrastructures and the emergency shelters, and for emergency planning purposes. With respect to the thunderstorm episode in Germany during May/June 2016, which lasted almost two weeks and caused heavy flooding in many localities (e.g., Braunsbach and Simbach), CEDIM's research focused on analyses of the probability of comparable events in the long-term. Through surveys in several municipalities affected, CEDIM researchers estimated runoff, flood wave height, and flow velocity to draw conclusions about the temporal sequence of the event by combining direct observations, statements of individuals affected, and video analyses. After Hurricane Matthew on 16 September 2016, which caused more than 1000 fatalities in Haiti alone, its meteorological background and socioeconomic effects were analysed.

In addition to these broad forensic analyses, CEDIM researchers have examined further extreme events and disasters primarily disciplinarily, which are also described briefly in Chapter I. This includes the earthquake in Amatrice (Italy) in August 2016, with an estimated damage of 2.6 billion USD, the heavy rain episode of November 2016 in Germany, the weaker earthquake on Lefkada (Greece) in November 2015 and in the same month, the heavy Mw=8.3 earthquake in Illapel (Chile), where the new Tsunami-model TsuKIT was applied for the first time. In addition to these CEDIM short reports, 131 reports about forthcoming extreme or unusual weather events worldwide were published on the web portal, "Wettergefahren-Frühwarnung."

Different CEDIM projects constitute the scientific basis of the FDA activities, where methods have been developed or improved during the last years to help analyse disasters in near-real-time, and which are applied in the case of an FDA activity (Chapter II). Within the scope of a project on crowdsourcing, natural disasters are detected, located, and classified in real-time via a self-developed software and taxonomy using social media posts. Based on past FDA activities, a further CEDIM project investigated factors that hamper effective communication during disasters and lead to significant information gaps, and identified the primary reasons for these situations. Two further projects are designed to estimate the risk of winter storms and tsunamis using probabilistic methods. While in the case of winter storms, a simplified approach is used that estimates damage by means of the intensity and spatial expansion of an event, combined with data about residential buildings, the estimation of the risk of a tsunami is based on the computation of wave propagation using up-to-date parallel processing hardware.

Forensic Disaster Analyses also are a focus of the current funding phase 2016-2018. Therefore, the research approach has been developed

[1] The term "Forensic Investigation of Disasters" (FORIN) has already been coined in 2010 in connection with natural disasters by the international research programme IRDR/ICSU (Integrated Research on Disaster Risk / International Council for Science). IRDR, with its forensic approach, follows up on the question of how natural hazards turn into disasters – or not.

further by integrating social science studies and sharpening the profile to include society's areas of demand of energy, mobility, and information. The objectives of the new CEDIM projects, which began at the end of 2016 and also are introduced briefly in Chapter II, are to scrutinize changes in risk and resilience attributable to social change, especially concerning energy, mobility, and supply systems, and critical infrastructures in urban areas. Work on the effects of natural hazards and social interactions on the street network of Chile, post-disaster rapid loss estimation, and the modelling of aftershocks complement these projects.

Several new collaborations were established in the last two years with international research centers, such as the University of Adelaide, the VU university of Amsterdam, and Deltares, an independent institute that focuses on water research. Close connections continue with the insurance industry, especially with the Willis Research Network (WRN), where CEDIM is involved in a Flagship Project to develop a hail risk model for Europe and Australia. Further, CEDIM has developed risk models for both types of hazards, hail and flood, for the Sparkassenversicherung SV. CEDIM also has joined various national and international programs: the IRDR International Center of Excellence on Critical Infrastructures and Strategic Planning established in 2015, the new 10-years-program High Impact Weather of the World Meteorological Organization (WMO), and different programs of the World Bank and the Global Facility for Disaster Reduction and Recovery (GFDRR). Since 2016, CEDIM has been a member of the newly founded network, the Global Alliance of Disaster Research Institute (GADRI).

Outreach is another important pillar of CEDIM. This is being promoted actively, for example, in its own session at the European Geoscience Union (EGU), by several articles on the website Earth System Knowledge Platform (ESKP: www.eskp.de), as well as by numerous contributions in high-ranking media (e.g., New York Times, Die Zeit, FAZ, ARD, ZDF, ARTE, Deutschlandradio, and others). James Daniell, a CEDIM researcher, contributed an article, "Natural Disasters since 1900: Over 8 Million Deaths and 7 Trillion US Dollars damage," that garnered the highest number of quotations for the KIT in 2016. A summary of these activities is provided in Chapter III.

With its near-real-time analyses of major disasters, a research program that addresses new topics repeatedly, and its active public relations, CEDIM is now established successfully in the national and international research landscape and is visible widely to various user groups, such as the insurance industry, relief organizations, and governmental institutions. With its new focus, CEDIM contributes to all three of society's areas of demand—energy, mobility, and information—identified by the KIT umbrella strategy 2025, and is thereby in an excellent position to continue to pool risk research at KIT. For this reason, CEDIM, together with the KIT-Center Climate and Environment, has begun a process to improve the integration and networking of the various research activities at KIT in the fields of Risks, Catastrophes, and Security, and to develop a common strategy.

Michael Kunz
Stefan Hinz
Franz Nestmann

Vorwort

Das Center for Disaster Management and Risk Reduction Technology (CEDIM) ist eine interdisziplinäre Forschungseinrichtung im Bereich des Katastrophenmanagements. Nach über 10 Jahren erfolgreicher Kooperation mit dem Deutschen GeoForschungsZentrum Potsdam (GFZ) ist CEDIM im Januar 2016 in die alleinige Verantwortung des Karlsruher Instituts für Technologie (KIT) übergegangen. Derzeit sind daran 16 Institute des KIT beteiligt. Der vorliegende Bericht gibt einen Überblick über die Forschungsarbeiten und Aktivitäten von CEDIM in den Jahren 2015 und 2016.

Seit einigen Jahren liegt der Schwerpunkt der Forschungsarbeiten von CEDIM auf forensischen Katastrophenanalysen in Nahe-Echtzeit (Forensic Disaster Analysis, FDA)[1]. Die Ziele dieses Forschungsansatzes sind es, unmittelbar nach dem Eintreten einer Katastrophe diese zu bewerten, die Folgen abzuschätzen, die zeitliche Entwicklung nachzuverfolgen und die wichtigsten Faktoren zu identifizieren, die für die Auswirkungen maßgeblich sind. Im Rahmen einer CEDIM FDA-Task Force Aktivität werden zeitnah, also wenige Stunden bis Tage/Wochen nach dem Eintreten einer Katastrophe, Berichte mit unterschiedlichen Schwerpunkten verfasst. In einigen Fällen werden diese Analysen ergänzt durch spezifische Feldeinsätze vor Ort.

Auch in den vergangenen beiden Jahren kam es zu mehreren CEDIM FDA Aktivitäten, die ausführlich in Kapitel I beschrieben sind. So analysierte ein Team von Wissenschaftlern nach dem schweren Erdbeben in Nepal am 25. April 2015 detailliert die damit verbundenen Auswirkungen in verschiedenen Regionen und die Intensität und Häufigkeit von Nachbeben. Bei insgesamt drei Feldeinsätzen (Juni und November 2015; April 2016) wurden verschiedene Befragungen vor Ort durchgeführt, um die Situation in den Notunterkünften näher zu beleuchten, Entscheidungskriterien für eine Evakuierung nachzubilden und bestehende Informationsdefizite der Bevölkerung zu eruieren. Darauf aufbauend wurde ein konzeptionelles Modell erstellt für die Abschätzung der Resilienz kritischer Infrastrukturen, für die Notfallvorsorge und die Vulnerabilität innerhalb der Notunterkünfte. Bezüglich der fast zwei Wochen andauernden Gewitterepisode im Mai/Juni 2016 in Deutschland mit schweren Überschwemmungen vieler Ortschaften (beispielsweise Braunsbach und Simbach) konzentrierten sich die Forschungsarbeiten von CEDIM vor allem auf Analysen der Wahrscheinlichkeit vergleichbarer Ereignisse in einem langzeitlichen Kontext. Bei Erhebungen vor Ort in mehreren betroffenen Kommunen konnten Wissenschaftler des CEDIM aus der Kombination von direkten Beobachtungen, Aussagen von Betroffenen und Videoanalysen Abfluss, Scheitelhöhe und Strömungsgeschwindigkeit schätzen und Rückschlüsse auf die Ereignisgenese ziehen. Nach Hurrikan Matthew im September 2016 mit über 1000 Todesopfern allein in Haiti wurden in einer weiteren FDA Aktivität sowohl die meteorologischen Hintergründe als auch die sozioökonomischen Auswirkungen dieser Katastrophe analysiert.

Neben den breit angelegten forensischen Analysen untersuchten CEDIM Wissenschaftler weitere Extremereignisse und Katastrophen vor allem disziplinär, die ebenfalls in Kapitel I kurz dargestellt sind. Hierzu zählen das Erdbeben von Amatrice (Italien) im August 2016 mit einem geschätzten Schaden von 2,6 Mrd. $, die Starkniederschlagsepisode im November 2016 in Deutschland, das schwächere Erdbeben auf Lefkada (Griechenland) im November 2015 sowie das schwere Mw=8,3 Erdbeben in Illapel (Chile) im gleichen Monat, bei dem erstmalig auch das eigene Tsunami-Modell TsuKIT zum Einsatz kam. Neben diesen CEDIM Kurzberichten wurden weitere 131 Berichte zu bevorstehenden extremen oder ungewöhnlichen Wetterereignissen weltweit verfasst und über das Webportal „Wettergefahren-Frühwarnung“ veröffentlicht.

Die wissenschaftliche Basis der FDA-Aktivitäten bilden verschiedene CEDIM-Projekte, deren Ziel es ist, Methoden zu entwickeln oder zu verbessern, mit denen Katastrophen im Rahmen einer FDA Aktivität zeitnah analysiert werden können (Kapitel II). Im Rahmen eines Projekts zu Crowdsourcing werden Naturkatastrophen in Echtzeit mit Hilfe einer eigens entwickelten Software und Taxonomie aus Beiträgen sozialer Medien detektiert, verortet und klassifiziert. In einem weiteren CEDIM-Projekt wird aus vergangenen FDA Aktivitäten untersucht, welche Faktoren eine effektive

[1] Der Begriff “Forensic Investigation of Disasters” (FORIN) im Zusammenhang mit Naturkatastrophen wurde im Jahr 2010 durch das internationale Forschungsprogramm IRDR/ICSU (Integrated Research on Disaster Risk / International Council for Science) geprägt. IRDR untersucht mit Hilfe des forensischen Ansatzes, wie aus Extremereignissen Katastrophen werden oder nicht.

Kommunikation während einer Katastrophensituation erschweren und welche maßgeblichen Informationslücken aus welchen Gründen vorherrschen. Zwei weitere Projekte haben zum Ziel, das Risiko durch Winterstürme und Tsunamis mit probabilistischen Methoden zu schätzen. Während im Fall von Winterstürmen ein vereinfachter Ansatz zum Tragen kommt, mit dem aus der Intensität und räumlichen Ausdehnung eines Sturms zusammen mit Daten über Wohngebäude auf den Schaden geschlossen wird, erfolgt bei der Risikoschätzung von Tsunamis eine genaue Berechnung der Wellenausbreitung mit Hilfe neuester Hardware zur Parallelprozessierung.

Forensische Katastrophenanalysen stehen auch im Mittelpunkt der aktuellen Förderphase 2016-2018. Dabei wurde der Forschungsansatz weiterentwickelt - durch verstärkte Integration gesellschaftlicher und sozialwissenschaftlicher Fragestellungen und durch eine Profilschärfung auf die gesellschaftlichen Bedarfsfelder Energie, Mobilität und Information. Die erst Ende 2016 begonnenen neuen CEDIM Projekte, die ebenfalls in Kapitel II kurz vorgestellt werden, haben zum Ziel, die mit dem gesellschaftlichen Wandel verbundenen Änderungen des Risikos und der Resilienz näher zu untersuchen, insbesondere hinsichtlich von Energie-, Mobilitäts- und Versorgungssystemen bzw. urbanen kritischen Infrastrukturen. Ergänzt werden diese Projekte durch Arbeiten über die Auswirkungen von Naturgefahren und sozialen Interaktionen auf die Funktionalität des Straßennetzwerkes von Chile, durch schnelle Schadenschätzung nach Naturkatastrophen und durch die Modellierung von Nachbeben.

In den vergangenen beiden Jahren wurden mehrere neue Kooperationen mit verschiedenen internationalen Forschungseinrichtungen etabliert, etwa mit der Universität Adelaide, der VU Universität Amsterdam oder Deltares, einem unabhängigen Institut mit Schwerpunkt in der Wasserforschung. Enge Verbindungen bestehen nach wie vor mit der Versicherungsindustrie, insbesondere mit dem Willis Research Network (WRN), bei dem CEDIM in einem sog. „Flagship Project“ an der Entwicklung eines Hagelrisikomodells für Europa und Australien beteiligt ist. Weiterhin erstellt CEDIM für die Sparkassenversicherung SV eigene Risikomodelle für die beiden Gefährdungsarten Hagel und Hochwasser. Außerdem ist CEDIM verschiedenen nationalen und internationalen Programmen beigetreten: dem in 2015 eingerichteten IRDR International Center of Excellence zu kritischen Infrastrukturen und strategischer Planung, dem neuen 10-Jahres Programm High Impact Weather der World Meteorological Organization (WMO) und an verschiedenen Programmen der World Bank und der Global Facility for Disaster Reduction and Recovery (GFDRR). Seit 2016 ist CEDIM außerdem Mitglied des neu gegründeten Netzwerks Global Alliance of Disaster Research Institute (GADRI).

Weiterhin ist die Außendarstellung eine wichtige Säule von CEDIM. Dies wird aktiv befördert etwa durch eine eigene Session bei der European Geoscience Union (EGU), durch vielfältige Artikel bei der Internetpräsenz Earth System Knowledge Platform (ESKP; www.eskp.de) sowie durch zahlreiche Beiträge in hochrangigen Medien (z.B. New York Times, Die Zeit, FAZ, ARD, ZDF, ARTE, Deutschlandradio u.a.). Auch die Presseinformation, die im vergangenen Jahr die meisten Zitierungen für das KIT insgesamt einbrachte, war von einem Wissenschaftler von CEDIM („Bilanz von Naturkatastrophen seit 1900: acht Millionen Tote, sieben Billionen Dollar Schaden“ von James Daniell). All diese Aktivitäten sind in Kapitel III zusammengefasst.

Mit seinen zeitnahen Analysen zu Katastrophen, einem Forschungsprogramm, das immer wieder neue Themenfelder federführend erschließt, und der aktiven Öffentlichkeitsarbeit hat sich CEDIM erfolgreich in der nationalen und internationalen Forschungslandschaft etabliert und ist weithin sichtbar bei verschiedenen Nutzergruppen wie Versicherungen, Hilfsorganisationen oder staatlichen Einrichtungen. Durch die neue Ausrichtung trägt CEDIM außerdem zu allen drei gesellschaftlich relevanten Bedarfsfeldern der KIT Dachstrategie 2025, Energie, Mobilität und Information, bei und ist damit bestens aufgestellt, die Risikoforschung am KIT weiter zu bündeln. Gemeinsam mit dem KIT-Zentrum Klima und Umwelt hat CEDIM daher auch im vergangenen Jahr einen Prozess angestoßen, die am KIT bestehenden und breit gestreuten Forschungsaktivitäten zu den Themenfeldern Risiken, Katastrophen und Sicherheit besser zu vernetzen und eine gemeinsame Strategie zu entwickeln.

Michael Kunz
Stefan Hinz
Franz Nestmann

I. FDA Activities

FDA Reports

CEDIM Investigations on the 2015 Nepal Earthquake

Trevor Girard, Bijan Khazai,
Geophysical Institute (GPI)

Sebnem Duzgun
Middle East Technical University, Department of Mining Engineering, Ankara

Introduction

Following the devastating 7.8 magnitude Gorkha Earthquake on 25 April 2015 and its aftershocks, approximately 2.3 million people were displaced. A team of CEDIM researchers responded to the April 2015 Nepal Earthquakes by producing valuable reports within days and weeks of the disaster and executing two separate field investigations within months. Four consecutive FDA reports were issued on April 27th, May 5th, May 12th and July 15th.

A CEDIM research team carried out field investigations in Nepal to examine shelter protection options and information needs following the devastating Nepal Earthquake. In an initial field survey from June 6 – 20th 2015, CEDIM researchers carried out a household level survey of displaced populations to analyse the shelter response situation and decision factors influencing displaced households in seeking shelter and temporary housing. The team conducted 284 household surveys in 177 locations spanning 27 Municipalities/VDCs and 7 districts. In a second three-week mission starting on November 11th 2015, a survey of 420 individuals investigated the information seeking and communication behaviour of earthquake affected communities. In a third mission from April 20-30th 2016, one year after the devastation, a team of CEDIM researchers, including Dr. Bijan Khazai, Mr. Trevor Girard and Prof. Dr. H. Sebnem Duzgun conducted another 45 interviews with government officials, police, and news media broadcasters to examine the key issues in the recovery process, including breakdowns in the disaster information communication chain. In September 2016, the CEDIM team supported by Utsav Upreti and Shyam Thapa from AAROH, an experienced Nepali NGO, launched a new round of surveys which combined research on communication issues and road blockages due to landslides

Aims / Objective

Through multiple field investigations, the CEDIM team pursued a better understanding of the post-disaster situation in Nepal and aimed to develop and test conceptual models on the assessment of critical infrastructure vulnerabilities following earthquake triggered landslides, emergent issues and vulnerability factors in temporary shelters, and the communication behaviour of the earthquake affected communities and local government, respectively.

Fig. 1: People from Ree and Lapa VDC Dhading whose villages were destroyed by landslides are sheltering on the hills near the district capital Dhading Besi (Photo: J. Anhorn).

Project status

Shelter field investigations

Individuals in urban and rural areas of Nepal sought different shelter options from spontaneous tent camps close to their homes, to scattered

unofficial shelter areas to designated official shelter sites (Figure 1). The Gorkha earthquake created an unprecedented need for emergency shelter as well as temporary and transitional housing. The purpose of the study was to better understand the factors that increase vulnerability to being displaced from a disaster event. The research team investigated the emergent issues with respect to decision processes of displaced households seeking shelter and temporary housing. The household shelter survey (HSS) conducted about 6 weeks after the earthquake across 7 of the most affected districts has revealed several factors that aggravate population displacement. These include insufficient protection from heat and inclement weather (flooding from heavy rains); emotional difficulties; issues with privacy including access to safe sanitation; and social difficulties including experiencing discrimination and crime.

Fig. 2: Destroyed homes after the earthquake in Bhaktapur, Nepal. (Foto: S. Duzgun/KIT).

To understand the factors that aggravate disaster displacement, it is necessary to consider the process of displacement holistically. The physical impact of a hazard often will lead directly to population displacement. However, factors such as proximity of shelter site to damaged homes, fear of aftershocks and landslides and the upcoming monsoon influenced people's decision to seek different shelter options. In addition, socioeconomic vulnerability can exacerbate the severity of disaster displacement in different ways. We found that among the displaced population, the elderly, female-headed households, people with disabilities, and some ethnic groups were more adversely affected through increased vulnerability to violence, discrimination, inadequate shelter or other hazards. In particular, displaced households in settlements whose homes and livelihoods were wiped out by landslides are at risk of long-term displacement. We found that when households have issues, they are more likely to contact local government offices than anyone else. Hence, the local government plays a critical role in addressing the issues of all households. It is important however, that the government reaches out to those vulnerable groups mentioned above to ensure their particular needs are met, as well as those isolated in rural areas who may have limited capacity to communicate their needs.

Disaster communication field investigations

A key focus of the interviews, particularly in the 2016 field investigations, were on disaster response information and communication related questions. In total, 401 individuals and 20 local officials participated in the quantitative survey and 25 key informants in the qualitative interviews. The results provided evidence of patterns in the information seeking and communication behaviour of the different types of respondents. While confirming the importance of social media to those with internet access, the survey revealed that individuals from rural areas and women in general have disproportionately lower access to the internet than those from urban areas and men, respectively. The findings provide evidence to support the use of local government officials and radio stations to communicate with individuals who lack internet access.

It was also observed that some forms of ICT, such as television, were more vulnerable to impacts than others like smartphones and mobile phones. The information sources which proved to be most useful after the earthquake were radio, friends/family, and government officials (Figure 3). Challenges to obtaining information in the first week after the earthquake were associated with a lack of access to communication channels, issues with disaster message content and not knowing what information was available or where to find it. In contrast, the biggest challenge to collecting information about impacts and relief efforts for key informants-was blocked roads. Since officials rely on face-to-face communication in Nepal, blocked roads prevented those in the disaster communication system from travelling to meet one another.

An official flow of disaster response information was also observed in Nepal for the dissemination of information about aid. The official flow used two-way channels of communication over one-way channels, which is critical to seeking feedback from communities. Overall, individuals trusted government officials more than other agencies, and expected officials to warn them of future risks.

Finally, the surveys and interviews identified local and district officials, police, radio stations and emergent groups to be key actors in disaster communication.

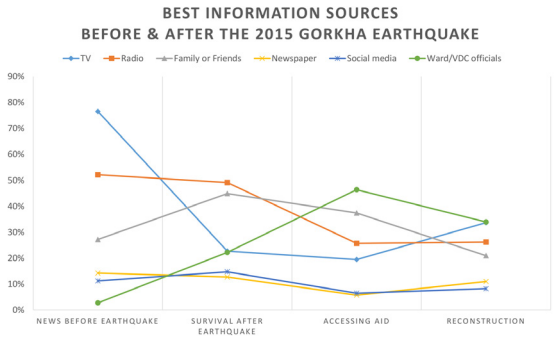

Fig. 3: Best information sources before and after the 2015 Gorkha Earthquake.

Critical Infrastructure Vulnerability

CEDIM researchers also investigated the role of accessibility and disruptions in transportation in the recovery process. Adverse conditions created by India's September blockade of transportation networks across the India-Nepal border, created a second wave of disruptions for delivery of fuel, food and goods following the widespread road disruptions caused by the earthquake and subsequent landslides. CEDIM researchers found the average response time to clear roads due to medium-size and large landslides was 1-2 and 5-7 days, respectively, but lack of skilled human power and maintenance equipment were major obstacles to road clearance. Some remote villages were inaccessible for up to 10 months following the earthquake, but for the urban areas that were interviewed the road blockages were cleared within the first month following the earthquake. However, during this time prices of commodities doubled due to the double impact of road disruptions by the earthquake, and the fuel blockade. It was also found that the relief efforts and recovery activities were considerably affected by road blockages due to landslides. One of the major roads connecting Nepal to China has still not come back to its original service due to intense and large landslides triggered by the earthquake.

Outlook

The CEDIM team presented the results of their research at the International Conference on Earthquake Engineering and Post Disaster Reconstruction Planning in Bhaktapur, Nepal. The team plans to continue its research collaborations with local Nepali organizations such as the National Society for Earthquake Technology (NSET) and Kathmandu Living Labs (KLL). By transferring the knowledge gained by the in-depth research to these local organizations who are already working with government authorities, the research can help influence local disaster risk reduction initiatives.

Die Untersuchung des Erdbebens in Gorkha (Nepal) 2015 durch CEDIM

Durch das verheerende Erdbeben der Stärke 7,8 in Gorkha, Nepal am 25. April 2015 und den zahlreichen Nachbeben in den Folgewochen wurden etwa 2,3 Millionen Menschen aus ihren Häusern vertrieben. Bei verschiedenen Feldeinsätzen hat ein Forscherteam des CEDIM in Nepal die Vor- und Nachteile innerhalb der unterschiedlichen Notunterkünfte sowie den Informationsbedarf der Menschen in Notsituationen untersucht. Bereits im Juni 2015 wurde eine Umfrage vor Ort durchgeführt, um Information über die Situation in den Notunter-künften zu erhalten und um mehr über Entscheidungskriterien bei der Auswahl der Notunterkünfte bzw. kurzzeitigen Unterkünften zu erfahren. In einer weiteren Umfrage im November 2015 ging es insbesondere darum, zu erfahren, wie die Menschen nach Informationen über die Katastrophenlage gesucht haben und welche Kommunikationsmittel genutzt wurden. Interviews mit Regierungsbeamten, Polizisten und Nachrichtendiensten wurden im April 2016 durchgeführt, um die Bewältigung der Katastrophe einschließlich der Schwierigkeiten in der Katastrophenkommunikation zu beleuchten. Die Interviews halfen unter anderem den CEDIM Wissenschaftlern, die verschiedenen Katastropheninformationen und Kommunikationssysteme, die in Nepal nach dem Erdbeben etabliert wurden, mosaikartig zusammenzusetzen. Außerdem hat das interdisziplinäre CEDIM Wissenschaftlerteam untersucht, welche Rolle beim Wiederaufbau die Zugänglichkeit bzw. Zerstörung der Transportwege gespielt hat. So haben nicht nur die Zerstörungen durch die Erdbeben und Hangrutschungen zu erheblichen Schwierigkeiten bei der Versorgung der Bevölkerung geführt, sondern auch die indische Blockade der indisch-nepalesischen Grenze brachte die Lieferung von Treibstoff, Lebensmitteln und weiterer Güter erheblich ins Stocken.

Severe Thunderstorm Episode May/June 2016 Germany

Michael Kunz, David Piper, Bernhard Mühr, Florian Ehmele, Susanna Mohr
Institute of Meteorology and Climate Research (IMK)

James Daniell
Geophysical Institute (GPI)

Andreas Kron
Institute for Water and River Basin Management (IWG)

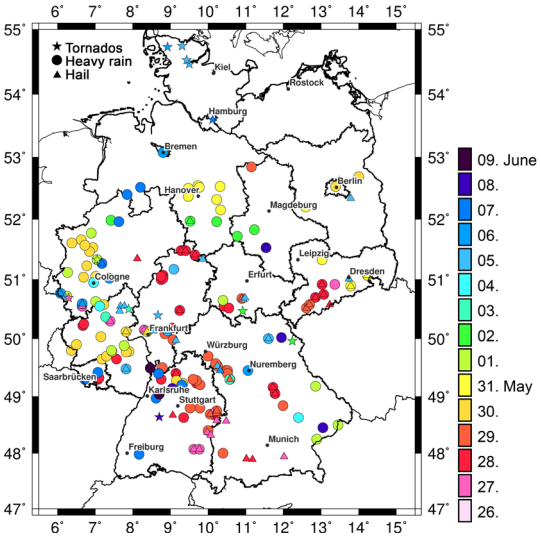

Fig. 1: Weather phenomena associated with severe convective storms between 26 May and 9 June 2016 collected from various sources of information (European Severe Weather Database, newspaper articles, weather services; Piper et al., 2016).

Introduction

During a two-week period in May and June 2016, large parts of Germany were repeatedly affected by severe thunderstorms (Fig. 1). Extreme rain exceeding 100 mm within 1-2 hours led to dramatic rise of water levels of various creeks. On 29 May, a flash flood with a wave height of up to 3.5 m damaged around 80 buildings in Braunsbach (Baden-Württemberg; Fig. 2). Only three days later, an extreme flood struck the town of Simbach (Bavaria). The Ahr valley (Rhineland-Palatinate) experienced heavy rain events even on multiple days leading to the worst flood ever reported. According to extreme value analyses for 24-hour and 7-day rain totals, return periods exceeded 200 years or even more in several regions. Around 7,000+ structures were affected in some way, leading to total damage in the order of € 1.2 bn, mostly due to a few major business losses (GDV, 2016; www.gdv.de).

During an FDA activity, CEDIM researchers focused on the meteorological aspects of the event, especially on the analysis of the persistency of specific weather patterns, and estimated inundation and runoff in Braunsbach from two surveys.

Atmospheric conditions

Prior to the thunderstorm episode, moist and warm subtropical air masses were advected towards Germany, where insolation additionally led to instability. The remarkable length of the storm episode can be attributed to a strong high-pressure ridge flanked by two low-pressure troughs persisting over several days. Moreover, the wind speed was unusually low allowing for thunderstorms to become almost stationary, yielding locally extreme rain accumulations.

Hydrological and hydraulic aspects

During two field trips of CEDIM researchers, over 700 recordings were made of water heights with 450 points used in the end to derive the inundation at each building in Braunsbach affected by flooding. In the catchment of the Schlossbach like in several other creeks struck by the thunderstorms, driftwood and floating debris was washed into the v-shaped valley and caused a jam in a culvert upstream of Braunsbach. The following runoff was dammed up and released spontaneously comparable to a dike breach. Velocities of 10-15 ms^{-1} were estimated upstream between Orlach and Braunsbach from a combination of video, local estimates from vegetation and from local people.

In Braunsbach, the Orlacher and Schlossbach creeks provided the most severe flooding of the town, with velocities of 7-10 ms^{-1}. The observed flood wave in the Schlossbach reached heights of 3.5 m scouring a new pathway in the built-up area of Braunsbach as well as overtopping the street causing high velocity flooding down the very steep slope, affecting many buildings on the ground flood and flooding cellars. While the

Orlacher Bach is designed upstream to accommodate flows of 15-20 m^3s^{-1}, more than 80 m^3s^{-1} were estimated. Additional runoff of 20 m^3s^{-1} at Schlossbach contributed to the flash flood. Both estimates are consistent with a flat area check. Assuming a height of 110 mm on average across the 6.4 km^2 catchment, the total water volume affecting Braunsbach is estimated to 700,000 m^3. The mass of debris from upstream landslides, hydraulic effects, road washouts and sediment transport contributed greatly to the impact downstream in Braunsbach.

Persistence of weather and atmospheric patters

To put the 2016 thunderstorm episode in the historical context, the probability of different atmospheric patterns were statistically assessed (Piper et al., 2016) with respect to a 55-year reference period. It was found that clusters of 10 consecutive days exhibiting extreme precipitation anywhere in Germany have occurred only three times before (exceedance of the 99.9% percentile; REGNIE data provided by German Weather Service DWD). Similar results were obtained regarding compound events with low atmospheric stability and weak mid-troposphere flow. A 13-day cluster for that combination, as observed in 2016, has been found only twice during the 55-year reference period. Furthermore, the application of a new weather pattern method that allows us to determine the potential for thunderstorms to occur yielded a cluster of 11 consecutive convective days. Evaluating the entire reference period statistically results in a probability of less than 1% for such a cluster as observed in 2016.

Fig. 2: Structural damage in Braunsbach after the 29 May 2016 flash flood (Image credit: James. E. Daniell).

Die schwere Gewitterepisode im Mai/Juni 2016 in Deutschland

Während einer fast 15-tägigen Episode vom 26. Mai bis 9. Juni 2016 kam es in Deutschland zu einer außergewöhnlich großen Zahl von schweren Gewittern, die mit schweren Niederschlägen, teilweise auch mit Hagel und Tornados, verbunden waren. Die schwersten Hochwasser und Sturzfluten ereigneten sich in Braunsbach (29. Mai) und in Simbach/Inn (1. Juni). Bei Erhebungen vor Ort in und um Braunsbach ließen sich aus der Kombination von direkten Beobachtungen, Aussagen von Betroffenen und Videoanalysen, der Abfluss, die Scheitelhöhe des Abflusses und die Strömungsgeschwindigkeit schätzen. Ein geschätzter Abflusswert von fast 100 m^3s^{-1} in Braunsbach erklärt die schweren Auswirkungen mit 80 zum Teil erheblich beschädigten Gebäuden. Die Wahrscheinlichkeit für das Auftreten einer Gewitterepisode vergleichbar zu der in 2016 ist sehr gering. Cluster mit 10 aufeinander folgenden Tagen, an denen in einer beliebigen Region in Deutschland Extremniederschlägen fielen, wurden in einem 55-jährigen Kontrollzeitraum nur dreimal registriert. Ähnliches gilt für die Kombination von geringer atmosphärischer Stabilität und geringer Windgeschwindigkeit bzw. gewitterförderlichen Großwetterlagen.

Hurricane Matthew, September 2016

Bernhard Mühr, Jan Wandel, Michael Kunz
Institute of Meteorology and Climate Research (IMK)

Introduction

On 23 September 2016, hurricane Matthew arose from a tropical wave west of West Africa. Travelling westward, the area of deep convection organized into a tropical storm on 28 September 2016 and was named "Matthew". While intensifying into a category 1 hurricane, Matthew continued its westerly track and moved over the easterly Caribbean. The hurricane showed a rapid intensification and deepened from a category 2 into a category 5 hurricane (highest category on the Saffir-Simpson hurricane wind scale) within just 15 hours. 1-minute sustained wind speeds increased from 85 kt (157 kph) to 140 kt (259 kph). The hurricane kept category-5-intensity for a few hours only and then became upper category 4. Matthew changed its track following a northerly direction, and on 4 October 2016 the storm's centre crossed Haiti's coastline. After raging through the Bahamas Matthew followed the coastline of Florida into a north westerly direction. Being a category 3 hurricane, its centre was very close to the coast but stayed offshore, shifting along Georgia's Atlantic coast before making landfall in South Carolina for a short while as a category 1 storm on 8 October 2016. The next day, Matthew followed a track into an easterly direction away from the US-coast and lost hurricane status.

With Matthew being a hurricane of the highest category, affecting many countries and causing billions of US$ of damage and many casualties, CEDIM started an FDA activity to investigate the hazard in terms of both meteorological and socioeconomic aspects in near real-time.

Track of Matthew, wind and precipitation

Matthew set many new records for intensity, longevity and landfall. During its lifetime, Matthew had multiple (4) landfalls, in Haiti, Cuba, the Bahamas and in South Carolina (USA). The first and most fatal landfall was near Les Anglais in Haiti as a category 4 storm on 4 October 2016 around 11 UTC with maximum sustained winds of 125 kt (232 kph).The next two landfalls took place in Cuba (near Juaco, 5 October 2016, 00 UTC as category 4) and on the Bahamas (close to Freeport, 07 October 2016, 00 UTC, as category 4). Finally, the centre of category-1-hurricane Matthew struck South Carolina, USA, near McCleanville on 8 October 2016, 15 UTC. Measurements with satellite and satellite based precipitation radar showed values of more than 200 mm all along Matthew's path through the Caribbean to the Bahamas. When Matthew was in its rapid intensification stage, precipitation amounts exceeding 625 mm have been derived. Over land and along the south coast of Haiti and the Dominican Republic the widespread rainfall amounts were 400-500 mm. Hourly rain rates were as high as 229 mm in the inner rain bands.

Fig. 1: Devastation in Haiti after Matthew has made landfall. Image source: Engineers Without Borders.

Matthew also brought extremely large volumes of rain to the Southeast of the USA and set numerous new records. Torrential rain fell from Florida all the way up to Virginia and even across parts of eastern Canada. These regions not only saw coastal floods, but many of the rivers had new all-time high water levels causing severe flooding.

Loss analysis

Matthew claimed many fatalities reported from the United States (46), the Dominican Republic (4), Colombia (1) and St. Vincent and the Grenadines (1). But most of all, Hurricane Matthew has left behind widespread destruction across Haiti and the death toll rose to more than 1000.

For the US, Matthew is the most expensive Atlantic hurricane since Sandy in 2012, causing an overall loss of more than $ 15 bn. In total, 26 Million people were affected by the hurricane in the US. For the Bahamas Matthew likely was responsible for the largest insured losses from a hurricane ever. In Haiti, these losses were in the order of $ 2 bn.

Further reading

http://www.wettergefahren-fruehwarnung.de/Ereignis/20161004_e.html

http://www.cedim.de/download/FDA_matthew_2016_report1_update2.pdf

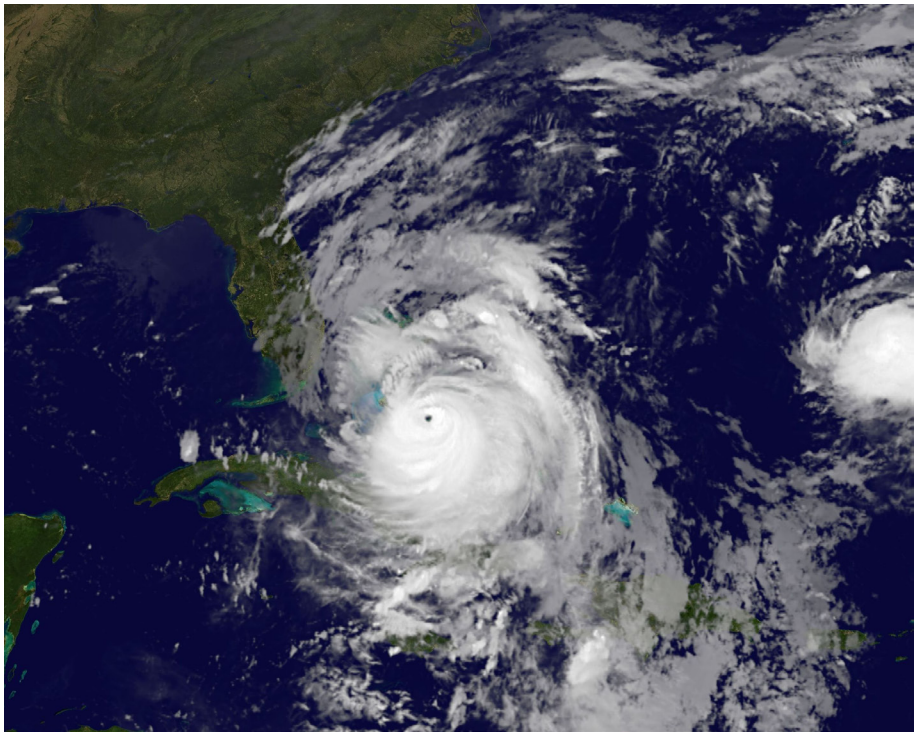

Fig. 2: Satellite image, 06 October 2016, 08:37 UTC. (Image credit: NASA GSFC GOES Project).

Hurrikan "Matthew", September 2016

Mit Hurrikan "Matthew" zog Ende September / Anfang Oktober 2016 ein tropischer Wirbelsturm über den Atlantik und durch die Karibik, der sich in vielerlei Hinsicht als ungewöhnlich erwies. Er hinterließ nicht nur ein Schneise der Verwüstung, sondern stellte in Bezug auf Intensität, Langlebigkeit und der Übertritte auf Land zahlreiche neue Rekorde auf. Matthew erreichte die höchste Wirbelsturm-Intensität, soweit südlich gelang das keinem Hurrikan zuvor (100 km nördlich von Kolumbien). Matthew trat insgesamt 4 Mal auf Land über (Haiti, Kuba, Bahamas, USA). Entlang seiner Zugbahn forderte der Hurrikan viele Todesopfer, mehr als 1000 alleine in Haiti. Sturm und sintflutartige Regenfälle führten zu großen Überschwemmungen. In den betroffenen Staaten kam es zu umfangreichen Evakuierungsmaßnahmen. Hurrikan Matthew war eines der teuersten Naturereignisse für die USA mit Schäden von mehr als 15 Mrd. $. Auch auf den Bahamas sorgte Matthew für größere versicherte Schäden als je ein Hurrikan zuvor. Angesichts der Intensität des Wirbelsturms, seiner Zugbahn, und seines enormen Schadenspotentials startete CEDIM eine FDA - Aktivität. In Nahe-Echtzeit wurden dabei sowohl die meteorologischen Hintergründe als auch die sozioökonomischen Auswirkungen analysiert.

Short Reports

Earthquake Amatrice 2016

James Daniell, Andreas Schäfer
Geophysical Institute (GPI)

Bernhard Mühr
Institute of Meteorology and Climate Research (IMK)

Antonios Pomonis
World Bank, Social, Urban, Rural & Resilience (GSURR)

A reduced FDA activity was undertaken post-earthquake for the 2016 Amatrice earthquake. Significant damage was seen in the epicentral area caused by one of the largest earthquakes of the last 50 years in Italy.

The earthquake caused about 295 fatalities and an estimated loss of about $ 2.58 bn, however with the recent aftershocks, the loss bill has been put at much higher with damage now in Norcia and other more densely populated regions in October 2016 and January 2017 earthquake sequences. In the August quakes, most affected were the towns of Amatrice and Accumoli. In contrast to the L'Aquila earthquake in 2009, the 2016 event was not preceded by a significant swarm activity, which lasted in 2009 for several months and caused wide-spread discussions about earthquake predictability, awareness and public warning. The earthquake sequence of 2009 not only shares common characteristics with the 2016 events but also those in 1997, the Umbria Marche earthquake sequence, just 35 km north of Amatrice. This was significantly similar to the 2016 but caused only 11 fatalities.

Two key historical events occurred around this location, including the 1639 earthquakes in October where great damage occurred and buildings and livestock were greatly affected and over 500 deaths and 800,000 crowns of building damage were seen. Similarly in January 1703, much damage in Amatrice and Accumoli was seen with 2000+ deaths and over 1.4 m crowns in damages.

Intensities reached VIII-IX on the MMI scale – very well built structures received slight damage, whereas older buildings suffered great damage. The damage seen corresponds to VIII and perhaps very isolated VIII-IX locations on the MMI scale.

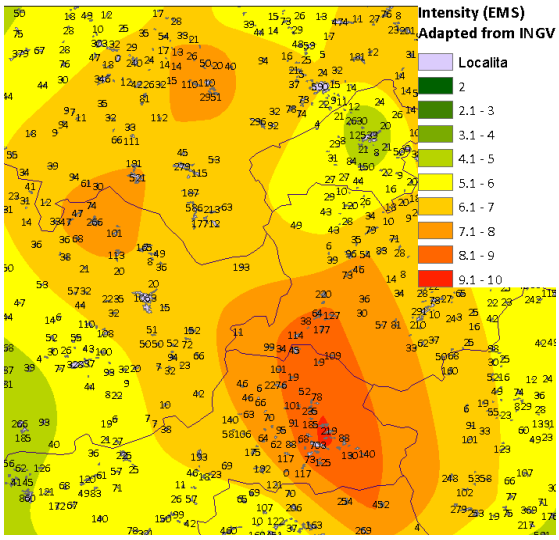

Fig.1: Buildings per town vs. intensity bounds as collected from census data for this earthquake in August showing the small town nature.

Being August, the population of the mountain top towns would have been higher than at the census, with unknown numbers of people staying in hotels, hostels, with family and other locations throughout the region. The region is a bit poorer than most in Italy with around likely $ 2.5-3 bn stock exposed in the intensities over VII. It is important to note that this is a replacement cost as many older masonry buildings may have become dilapidated over the years. Many buildings in the mountains stay vacant during other times. It can be seen that the population is likely underestimated by 3+ times perhaps using building ratios from the V-VI region. The GDP in the region over intensity VI is ca. $ 3.3 bn. The Capital stock over VI is in the order of $ 18 bn.

The affected area was sparsely populated and mountainous, and is around 40 km to the North of the city of L'Aquila that was devastated in the April 2009 earthquake of similar magnitude. From north to south, within a distance of about

15 km, the worst affected were the villages of Pescara del Tronto (part of the Arquata del Tronto commune) – population 135, Accumoli – population 670 and Amatrice – population 2650 (incl. the surrounding villages). All three villages were situated on steep mountain ridges where slope instabilities and ground motion amplification can cause excess damage as has been seen in past events in Italy (e.g. 1976 Friuli and 1980 Irpinia). Inspection of damage photos suggests that Pescara del Tronto and Amatrice were devastated, losing a large proportion of their mostly residential building stock. In Amatrice there is a distinct new part of the village, with large public buildings and other facilities that is apparently less affected. The overwhelming majority of the buildings that collapsed were 2 to 4 story unreinforced stone masonry constructions with wooden floors. Some severe damage to reinforced concrete or hybrid construction buildings has also been seen, but it is limited in number, e.g. the Hotel Roma in Amatrice. Most of the masonry buildings are very old (built prior to 1920) and in need of substantial strengthening. This is a common problem in most of Italy's old rural settlements. In the affected villages most of these buildings collapsed either partly or entirely and very few will be salvaged.

The October and January earthquake events including an avalanche caused damage and deaths that are still being evaluated.

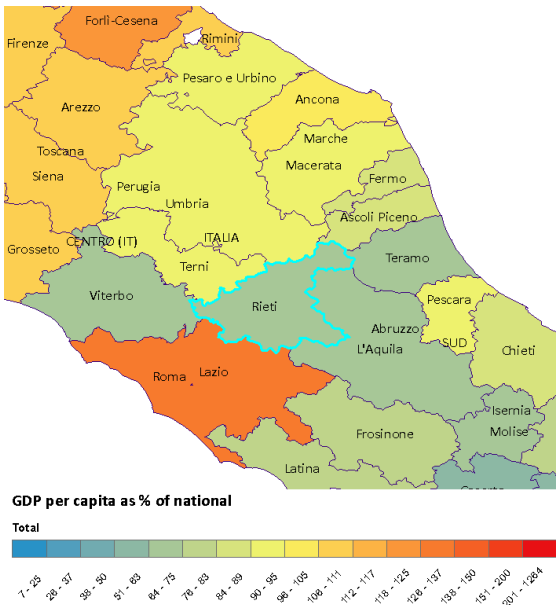

Fig.2: GDP per capita per province as a percentage of national, showing the disparity in income across the region. Amatrice in Rieti is a poorer region than many in Italy.

Das Amatrice Erdbeben 2016

Das Erdbeben in Amatrice, Italien, am 24. August 2016 um 1:36 UTC mit einer Magnitude von 6,0 verursachte ca. 295 Todesfälle und einen geschätzten ökonomischen Schaden von 2,58 Mrd. $. In Anbetracht der folgenden Sequenzen an Nachbeben bis in den Januar 2017 hinein, liegt der tatsächliche Schaden aber noch höher. Das Beben trat in einer Tiefe von etwa 4,2 km auf und die Intensitäten erreichten VIII – IX auf der Modified Mercalli Scale (MMI), bei welchen sogar sehr stabil gebaute Gebäude leichtere Schäden davontragen. Ältere Gebäude erlitten hingegen sehr starke Schäden. Am stärksten wurden die Ortschaften Amatrice und Accumoli getroffen. Dieses gebirgige Gebiet ist nur dünn besiedelt und liegt knapp 40 km nördlich der Stadt L'Aquila, die im April 2009 von einem Erdbeben ähnlicher Magnitude zerstört wurde.

Excessive Rain in Southern Germany, 19th to 21st of November 2015

Bernhard Mühr, Florian Becker, Michael Kunz
Institute of Meteorology and Climate Research (IMK)

Introduction

An extreme rain event occurred in November 2015 and mainly affected the southern parts of Germany (Baden-Württemberg and Bavaria). Despite rain amounts that exceeded previous 24- or 48-hour precipitation all-time records at some locations, no major flooding emerged. This fact is even more surprising since the rain event was widespread and ranked in second place for any day since 1951 in respect of the entire area of the Baden-Württemberg and for a 48 hours period.

Weather pattern and previous conditions

Before the rain event, the month of November 2015 showed extreme high temperatures across central Europe with temperature deviations between 6 and 10 K above normal. During this time there was only little or even no rain in Germany, especially in Baden-Württemberg and Bavaria. Moreover, a drought that had already began in February 2015, continued in southern Germany. Some locations got as little as 60% of the usual rain amount in 2015 until mid-November (e.g. Stuttgart).

From 19 to 21 November 2016 a frontal system established over central Europe and stretched along central parts of Germany and France all the way to the central North Atlantic Ocean. The frontal system became quasi-stationary and separated cold and dry air masses from subtropical moist and warm air masses to the south. With strong surface winds from south-westerly directions an effective moisture transport was established. Upper level short wave troughs provided some extra lifting and gave rise to small surface lows along the frontal system which moved rapidly from west to east. On 21 November the frontal system finally crossed the Alps. Cold and drier air could then penetrate from the north and made its way across entire Germany. It replaced the subtropical air masses and started a wintry episode.

Rain amounts and river gauges

Baden-Württemberg got an interpolated rain amount (48 hours) of 61.8 mm, which is the second highest following the record rainfall of May 1978 (85.9 mm). At Simonswald-Obersimonswald (Black-Forest) 115 mm within 24 hours was a new daily record.

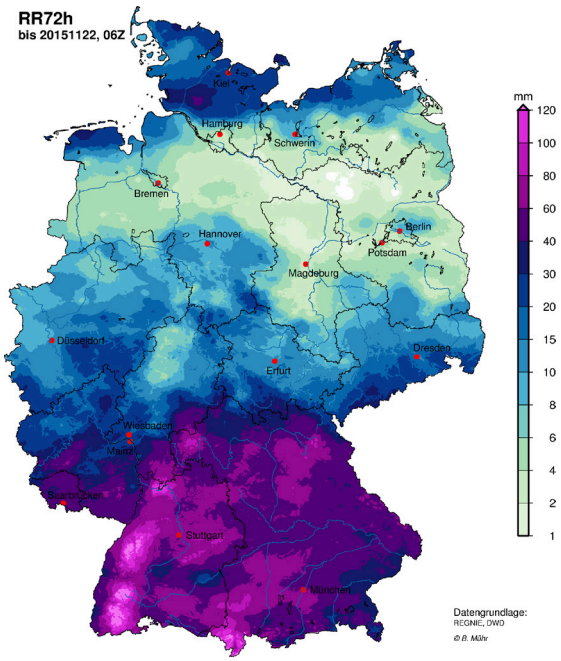

Fig. 1:72-h accumulated and interpolated rain amount (mm), based on station data, 19.-22.11.2015, 06 UTC.

The extraordinary high rainfall volumes had only minor impacts. Before the rain event nearly all rivers were running with low water levels During the event some rivers were in flood, but the flood was not dangerous, as the recurrence interval of nearly all gauges remained below 2 years.

Further reading

http://www.wettergefahren-fruehwarnung.de/Ereignis/20151121_e.html

http://www.cedim.de/download/CEDIM_FDA_RainEventGermany_20151120.pdf

Starkes Regenereignis in Süddeutschland, 19. - 21. November 2015

Ab dem 19. November 2015 ging eine monatelange Trockenzeit im Süden Deutschlands zu Ende. Seit Februar war in Baden-Württemberg und Bayern gebietsweise nur gut die Hälfte der in diesem Zeitraum sonst üblichen Regen-menge gefallen.
Entlang einer quasi-stationären Luftmassengrenze, die sich quer über Deutschland erstreckte, kam es zu anhaltenden, großflächigen und ergiebigen Regenfällen bis in höchste Lagen. Baden-Württemberg registrierte den nassesten 48-Stunden Zeitraum seit 1951, bezogen auf die gesamte Landesfläche gingen 61,8 mm Regen nieder.
Trotz der enormen Wassermassen blieb ein größeres Hochwasser aus. Vor dem Regen-ereignis führten die Flüsse Niedrigwasser und auch mit dem Starkregen stiegen die Pegel lediglich in den Bereich eines 2-jährigen Hochwassers. Es ist vor allem der außerordentlich trockenen Vorwitterung und der geringen Bodenfeuchten zuzuschreiben, dass sich kein großes Hochwasser bilden konnte.

Lefkada Earthquake Greece 2015

Andreas Schäfer
Geophysical Institute (GPI)

On 17th November 2015, a Mw=6.4 earthquake was reported at the island of Lefkada in Western Greece. It was the strongest earthquake in that region since 1997, although in 2003 a similarly large earthquake (Mw=6.3) had hit the same region. Based on the observed aftershock pattern and moment centroid results, a SW-NE strike-slip rupture was determined. Most quakes were hereby located to the South-West of Lefkada. The peak ground motion was modelled to be about 0.3 g in the epicentral region and about 0.14 g for the surrounding areas. This caused in total an earthquake intensity of MMI=VII. Two fatalities have been reported, one of them by rockfall, another one by falling debris; 8 more were injured. The impact was smaller compared to the earthquake in 2003 and other events, e.g. in 1948 or 1953. The economic impact was estimated to be about $ 20 m on average (range $ 5-65 m), but the indirect long-term damage may exceed the direct damage. For Lefkada, tourism is one of the most important business sectors and after any larger earthquake, a significant decrease in the number of visitors can be expected. In total, only about 120 houses have been damaged, leaving 20 of them uninhabitable. The whole event was associated by a number of landslides.

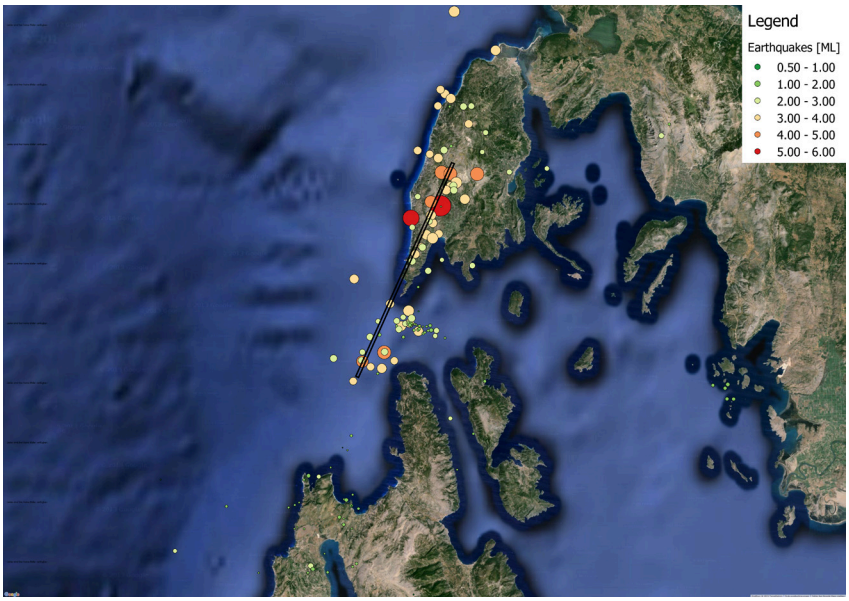

Fig.1: Earthquakes and aftershocks from the last 24 hours indicating the possible fault mechanism direction (fault length not indicated). The fault projection extends through the centre of Lefkada according to aftershock activity.

Lefkada Erdbeben 2015

Am 17. November 2015 ereignete sich ein Mw=6,4 Erdbeben im Südwesten von Lefkada im Westen von Griechenland. Dabei entstand ein Schaden von ca. 20 Mio. $, sowie 2 Todesfälle (1 durch einen Erdrutsch, 1 durch ein einstürzendes Gebäude). 8 weitere Menschen wurden verletzt. Insgesamt wurden ca. 120 Gebäude beschädigt, 20 davon sind unbewohnbar. Das Erdbeben war das stärkste seit 1997, die Folgen blieben jedoch deutlich geringer im Vergleich zu anderen Beben in der Region, bspw. 2003, 1948 oder 1953.

Illapel Earthquake Chile 2015

Andreas Schäfer
Geophysical Institute (GPI)

During the night of the 16th to the 17th of November in 2015, a massive Mw=8.3 earthquake hit the coast of Central Chile. The region has been frequently hit by very strong earthquakes in recent decades, including the 2010 Mw=8.8, Maule earthquake and the 1960 Mw=9.5 Valdivia earthquake. Compared to these disasters, the 2015 Illapel earthquake had only a minor-moderate impact. Nonetheless, it caused moderate damage, with an average expected economic loss of about $ 58 m. (range $ 12 m - $ 176 m). In total, 16 fatalities were recorded, one them indirectly during an evacuation procedure. Almost 5000 buildings were damaged, with a majority in Chile, but also some in Argentina and Brazil. Several landslides were reported, blocking streets. A tsunami was recorded in the Pacific, with maximum wave heights of at least 4 - 6 m in the epicentral region, 0.5 - 1.5 m for most of the Chilean coast and <0.5 m for the remaining Pacific. The TsuKIT model used proved its applicability for rapid impact assessments and will be used for future events.

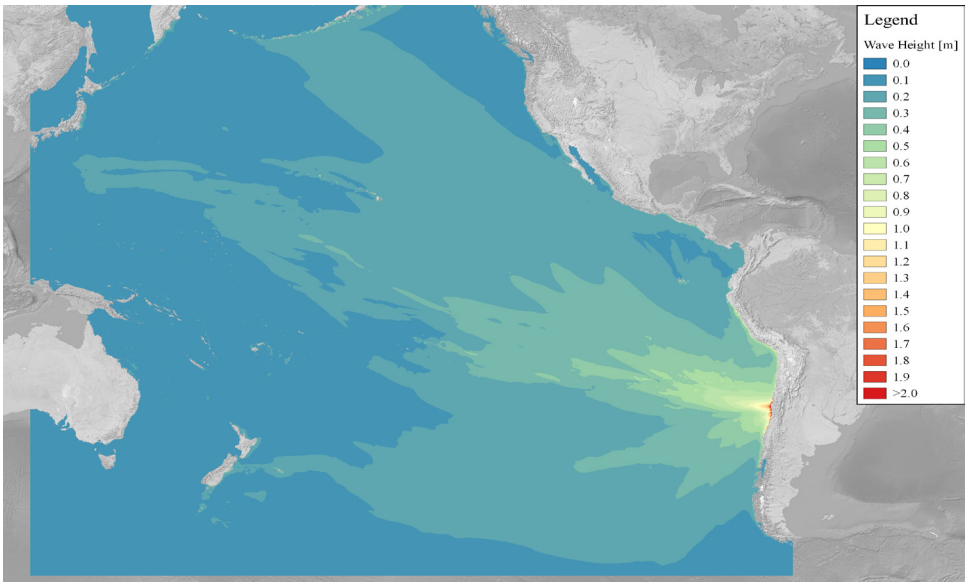

Fig.1: *Up to 4.5 m waves have been reported in Coquimbo close to the epicentre. Modelled using TsuKIT by Schaefer et al. (2015).*

Chile Erdbeben 2015

In der Nacht zum 17. November 2015 ereignete sich ein Mw=8,3 Erdbeben vor der Küste von Chile, welches darüber hinaus einen Tsunami zur Folge hatte. Im Vergleich zu anderen Starkbeben in der Region (1960, 2010) blieben die Schäden zwar überschaubar, aber dennoch beachtlich mit einer Höhe von ca. 58 Mio. $. Außerdem wurden 16 Todesfälle vermeldet. Der Tsunami erreichte eine maximale Höhe von ca. 4,5 m in der Nähe des Epizentrums und überflutete mehrere Küstenabschnitte.

II. Research

CEDIM Projects

Crowdsourcing - Using Social Media for Rapid Damage Assessment

André Dittrich, Stefan Hinz
Institute of Photogrammetry and Remote Sensing (IPF)

Introduction

In the case of natural and man-made disasters the temporal aspect of collecting information on the event as a whole as well as local on-site information is often crucial for decision support in disaster response organizations. Thus, for example, they are able to better coordinate their actions and provide help to the affected people.

The exploitation of social media streams has been proven to yield valuable information for this purpose in a near real-time manner, such as eyewitness accounts of first responders, estimated impact areas, and identification of smaller scale hot-spots within large-scale disaster areas. This information, e.g. from micro-blogs such as Twitter, which is difficult or impossible to be detected by conventional sensors, can be used to quickly detect disastrous events, to complement traditional sensors or to validate damage scenarios.

Aims / Objective

The objective of the project is to acquire real-time observations from eyewitnesses from a diverse range of Social Media sites. These observations are used to provide rapid damage and impact estimation. Additionally, other related, digitally accessible, platforms can be exploited to gather relevant (background) information on an event to semantically enrich Social Media data. Within our approach, we are aiming at different natural disaster events such as storms, floods, volcanic eruptions, and earthquakes. The specific challenge in using social media as an information source is to automatically extract the relevant information from the huge amount of data. Therefore, our goal is to develop algorithms that are able to a) handle the massive amount of data in real-time, b) filter the incoming data stream for disaster-relevant content and c) provide quick and reliable information for further analysis and decisions.

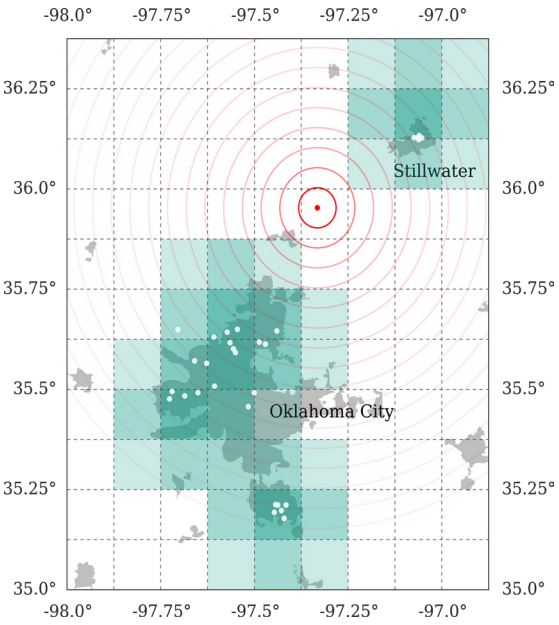

Fig.1:Detection of an earthquake event in Stillwater, Oklahoma on April 19th at 5:28:10 UTC. The map depicts the cells of the grid (dashed gray lines), the tweets (white dots), urban areas (medium gray), affected cells (green shaded rectangles) and the earthquake epicentre (red dot).

Project status

In order to extract valuable event information from the mass of available social media data and provide a real-time analysis in a fully automated way, several processing modules were designed and implemented.

Our research currently focuses on the extension and optimization of the developed TENAS software (Twitter Event Notification and Analysis Service). It is a framework that monitors geo-referenced Twitter messages based on a world-wide grid (20x20 km^2) in real-time and

operates day and night. The software is able to robustly detect significant increases in tweet volume for any area around the world compared to a weekly updated three month moving average baseline. The test for significance is based on different statistical models such as the Poisson distribution, the negative binomial distribution and the zero-inflated Poisson distribution, which are suitable for modelling count data. The subsequent analysis of the tweets' textual content identifies disaster related terms in more than 60 languages and classifies the event accordingly, e.g. as earthquake, thunderstorm, tornado, etc. The textual analysis relies on methods from information extraction and natural language processing. The classification of the event is then based on similarity measures of the retrieved messages with a domain taxonomy of natural disasters.

Within minutes after the start of a detected event, an automatic e-mail alert is sent to the subscribers of the service including the most important context information, such as affected area, the time of the detection and the automatically classified disaster type.

Outlook

In a next step, the team will investigate the usage of the information provided by TENAS as context knowledge for a more detailed analysis of single messages. The goal is a machine learning approach that is able to distinguish between messages that are relevant for disaster management and those that are not. Depending on the experiences with this approach, a finer categorization of the relevant messages in groups - such as damaged infrastructure, food/water supply, help arrived - might be beneficial. However, in order to retrieve more qualitative social media data, other platforms than Twitter need to be incorporated in the future (e.g. Instagram or Facebook).

Crowdsourcing - Verwendung sozialer Medien zur schnellen Schadensbewertung

Ziel des Projektes ist es, aus (Augenzeugen) Beiträgen in sozialen Medien, Naturkatastrophen in Echtzeit zu detektieren, verorten und klassifizieren zu können.

Hierzu wurde die Software TENAS entwickelt, welche zur Zeit erweitert und optimiert wird. TENAS extrahiert, speichert und wertet georeferenzierte Nachrichten aus dem Microblogging-Dienst Twitter aus. Mittels statistischer Verfahren werden zunächst Gebiete identifiziert, die aktuell eine signifikant erhöhte Nachrichtendichte aufweisen. Anschließend werden diese Nachrichten basierend auf Schlüsselbegriffen in 60 verschiedenen Sprachen und einer Taxonomie der Domäne Naturkatastrophen analysiert und einer spezifischen Katas-trophenart zugeordnet.

Bei Erkennen eines möglichen Katastrophenereignisses wird eine Benachrichtigung über E-Mail an alle Abonnenten des Service gesendet. Diese beinhaltet die wichtigsten Informationen wie die ermittelte Ereignisart, die betroffene Region, den Zeitpunkt der Detektion sowie eine Abschätzung der Detektions- und Klassifikationszuverlässigkeit.

Zukünftig soll der Output von TENAS verstärkt als Vorwissen zur Einzeltextanalyse und deren automatisierter Kategorisierung bezüglich ihrer Relevanz für das Katastrophenmanagement dienen.

Improving Communication with the Public during Disaster Situations

Trevor Girard
Geophysical Institute (GPI)

Introduction

Effective communication of disaster response information before, during and after a disaster event can save lives and help affected individuals access the aid they need to recover. Though the actors in the disaster communication system attempt to inform the public, a variety of communication problems can prevent their disaster messages from eliciting the desired response by

the public (e.g., evacuating or seeking aid). The result is that many individuals are impacted by disasters and lives are lost, despite warnings being issued. Likewise, many individuals suffer after disasters, despite information about aid being available.

Three case studies were implemented to gain an in-depth understanding of the communication behaviour of disaster affected individuals and local government during actual disaster situations. The disasters investigated were typhoons Haiyan (2013) and Hagupit (2014) in the Philippines and the Gorkha Earthquake (2015) in Nepal. During 2015 and 2016, more than 800 quantitative surveys were conducted with individuals and local officials from disaster affected communities, and 75 qualitative interviews were conducted with key informants from various government and non-government agencies.

Aims / Objective

A key purpose and result of earlier research was the development of a methodology to analyse disaster response information in near-real-time in order to identify potential information gaps. The purpose of this latest research was to identify key barriers to effectively communicate disaster response information (i.e., disaster warnings and relief information) to the public during disaster situations

Project status

The three case studies from the Philippines and Nepal demonstrated that although the system for distributing disaster response information is complex, with multiple actors and communication channels, clear patterns for obtaining disaster information were observed. For instance, in Nepal, significant variances were observed in the relation between location (urban vs rural) and access to information and communication channels. The findings support the argument that information sent through online channels are highly unlikely to reach rural areas. For all three cases, a clear shift was also observed in the information sources used before the disaster event and those used afterwards. Many of those who previously tuned into television and radio began relying on local officials, family and friends for disaster relief information. In general, the results revealed that

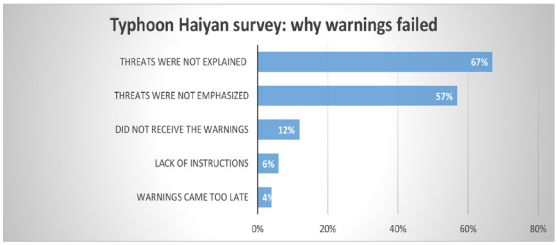

Fig.1: Typhoon Haiyan surveys: top selected answers by individuals to explain why warnings failed to convince them to evacuate prior to landfall (N = 55).

a variety of information seeking and communication behaviour were dependent on gender, location (urban vs. rural) and age. Information gap analyses were also completed for Cyclone Pam (2015) in Vanuatu and the Gorkha Earthquake (2015) in Nepal. Almost 100 disaster updates for these two disasters were analysed for their content and further analysis was conducted to identify potential gaps where more information could improve the situational awareness, and hence response, of the public. These are in addition to 19 disasters previously investigated. One of the assumptions that was verified by comparing the information gap analyses with the survey results was that there is a wealth of valuable information available online that fails to help disaster affected communities because it never reaches them. Furthermore, information that does reach the public may not be fully understood. In the Typhoon Haiyan case study, warnings were not understood because the hazards were neither explained nor emphasized (see Figure 1).

Outlook

Integrating the results of the case studies, information gap analyses and disaster literature has culminated in the development of a conceptual model of the typical disaster communication system (see Figure 2). The intent of the model is to enhance discussion of disaster communication plans and problem solving activities. The results of this research have practical implications for any individual or agency attempting to communicate with the public during a disaster situation. The goal for further research is to expand near-real-time information gap analyses to include an investigation of the variety of information sources and strategies for disseminating messages to the public during disaster situations.

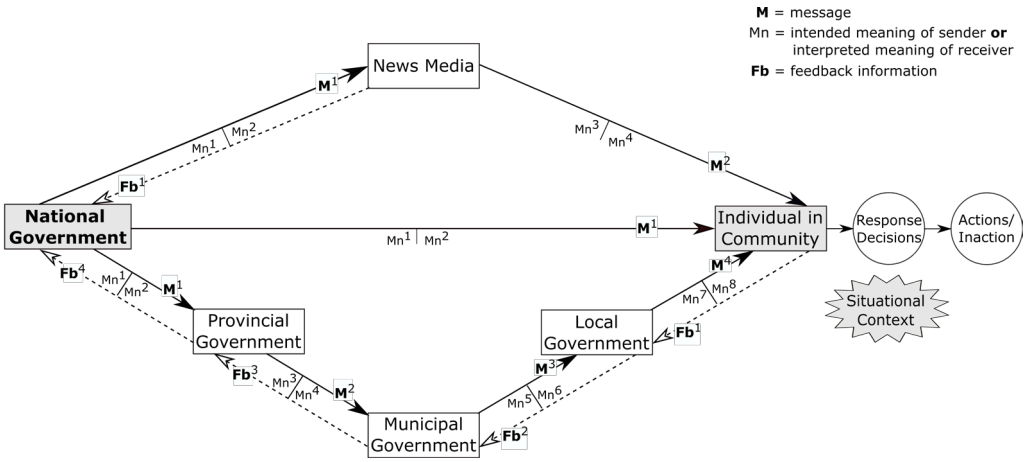

Fig.2: Typical pathways for a national government to disseminate disaster response information to the public.

Verbesserung der Kommunikation mit der Öffentlichkeit bei Katastrophensituationen

Das Ziel dieses Projekts ist es, festzustellen, welche Faktoren effektive Kommunikation innerhalb einer Katastrophensituation erschweren. Mit Hilfe von drei Fallstudien wurde ein tiefgreifendes Verständnis erlangt, wie Gefahrenabwehrinformationen die Allgemeinheit während einer Katastrophensituation tatsächlich erreichen. In diesem Zusammenhang wurden die Taifune Haiyan und Hagupit auf den Philippinen (2013 und 2014), sowie das Gorkha Erdbeben in Nepal (2015), untersucht. Quantitative Umfragen mit Betroffenen und lokalen Amtsträgern aus Katastrophengebieten wurden durchgeführt. Mit Schlüsselpersonen aus verschiedenen Regierungs- und Nichtregierungsorganisationen wurden qualitative Befragungen durchgeführt. Die Ergebnisse der Fallstudien zeigen wie Betroffene und Regierungsvertreter in beiden Ländern im Verlauf einer Katastrophensituation einerseits Informationen bereitstellen und verarbeiten und andererseits miteinander kommunizieren. Ebenso zeigen die Ergebnisse, dass Verhaltensweisen hinsichtlich Beschaffung und Kommunikation von Informationen von Geschlecht, Standort und Alter abhängen. Zugleich haben die Fallstudien verdeutlicht, wie und in welcher Form die verschiedenen Akteure miteinander kommunizieren. Schließlich zeigen die Ergebnisse der Befragungen, dass nicht immer die Kernbotschaften der Warnungen von der Öffentlichkeit tatsächlich verstanden werden.

Towards the Development of a Global Tsunami Risk Model

Andreas Schäfer, James Daniell, Friedemann Wenzel, Robert Eschbach
Geophysical Institute (GPI)

Introduction

The assessment of tsunami risk is on many levels still ambiguous and under discussion. Over the last two decades, various methodologies and models have been developed to quantify tsunami risk, most of the time on a local or regional level, with either deterministic or probabilistic background. Probabilistic modelling has significant difficulties, as the underlying tsunami hazard modelling demands an immense amount of computational time and thus limits the assessment substantially, being often limited to either institutes with supercomputing access, or the modellers are forced to reduce model resolution either quantitatively or qualitatively. Furthermore, data on the vulnerability of infrastructure and buildings is empirically limited to a few disasters that have occured in the recent years.

Aims / Objective

Thus, a reliable quantification of socioeconomic vulnerability is still questionable. Nonetheless, significant improvements have been made recently on both the methodological aspect as

well as computationally. Recently, we introduced a methodological framework for a globally uniform probabilistic tsunami risk assessment. Here, the power of recently developed hardware for desktop-based parallel computing (GPUs) plays a crucial role in the calculation of numerical tsunami wave propagation, accelerating the computation speed in the order of magnitudes. A large-scale parametric study on tectonic, geologic and paleo-seismological data was taken out for the quantification of megathrust earthquake potentials on more than 70 subduction zones worldwide.

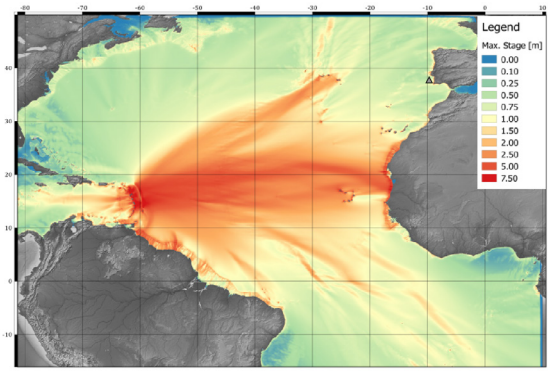

Fig.1: Potential impact pattern of a mega-thrust earthquake scenario along the Northern Lesser Antilles.

Project Status

The framework has been successfully applied for various studies:

- The framework was tested by considering wave propagation benchmarks (e.g. run-up on conical island) as well as comparison of recent buoy data observations from the 2013 Santa Cruz Island tsunami as well as the 2011 Tohoku tsunami.

- The 3 main parameters in tsunami wave propagation and inundation modelling, the source model, spatial resolution and available roughness/friction data were compared with respect to their sensitivity on inundation results, showing that the source is indeed the most important aspect of tsunami impact assessment.

- In the Caribbean, potential inundation impacts on several Lesser Antilles states have been quantified.

- The potential for future big earthquakes along the Puysegur Trench was analysed together with its respective possible impact on the coast line of South-East Tasmania.

- A sensitivity study was undertaken for the city of Lima, analysing the variability of inundation impact with respect to varying source slip distributions and epicentre location of a potential Magnitude 9 event. Adaptation of empirical tsunami vulnerability functions in conjunction with methodologies from flood modelling support a more reliable vulnerability quantification. In addition, methodologies for exposure modelling in coastal areas are introduced focusing on the diversity of coastal exposure landscapes and data availability.

Overall, the framework introduces a first overview of how a global tsunami risk modelling framework may be accomplished, while covering methodological, computational and data-driven aspects.

Outlook

Further development on the global tsunami risk model focuses on a global compilation of tsunami-genic earthquakes sources and their respective risk potential on major coastlines around the world. Future tsunami events can then be assessed quickly as part of a CEDIM's FDA activity. In addition, the numerical assessment of underwater mass movements is about to be added to the computational framework.

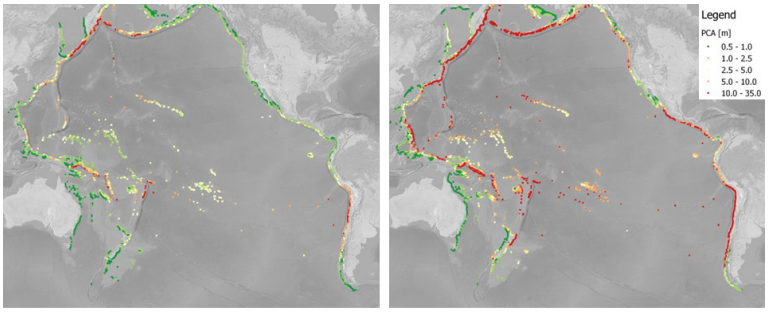

Fig.2: Peak Coastal Amplitude Maps with a 2% (right) and 10% (left) occurrence probability in 50 years.

Globales Tsunami Risiko Modell

Die Abschätzung des Tsunami Risikos ist in weiten Teilen noch nicht gut umgesetzt. Während der letzten zwanzig Jahre wurden verschiedene Methoden und Modelle entwickelt, um das Tsunami Risiko zu quantifizieren. In den meisten Fällen erfolgte dies auf lokaler oder regionaler Ebene, entweder deterministisch oder eingeschränkt mit einem probabilistischen Ansatz.

Die probabilistischen Ansätze können aufgrund ihrer Rechenintensität allerdings nur mit Hilfe von Supercomputern in adäquater Auflösung realisiert werden. Aus diesem Grund wurde im Rahmen des Projekts eine Methode für eine global einheitliche, probabilistische Tsunami Risikoabschätzung entworfen. Dabei spielt die Kapazität neuester Hardware zur Parallelprozessierung (auf GPUs) eine entscheidende Rolle zur schnellen Berechnung der Tsunamiwellenausbreitung.

Die Methode wurde bereits erfolgreich für mehrere Studien eingesetzt und gegenüber bestehender Benchmarks für Wellenausbreitungsberechnungen getestet.

The Web Service „Wettergefahren-Frühwarnung“ / Weather Hazards - Early Warning

Bernhard Mühr, Michael Kunz
Institute of Meteorology and Climate Research (IMK)

Overview

The internet service “Wettergefahren-Frühwarnung” provides information on imminent or just occurring unusual or extreme weather events worldwide; of particular interest are those weather events that are ruinous and associated with heavy losses. Permanent availability, daily updated (warning) information, editorially enhanced reports of extreme or unusual weather events that are enriched by images and measured values, are the hallmarks of the internet project.

Routine operation started on 1 February 2004 and has since been continuously maintained. All warnings, special notes and detailed reports can be found in an ever-growing archive and more than 1000 extreme events have been investigated so far.

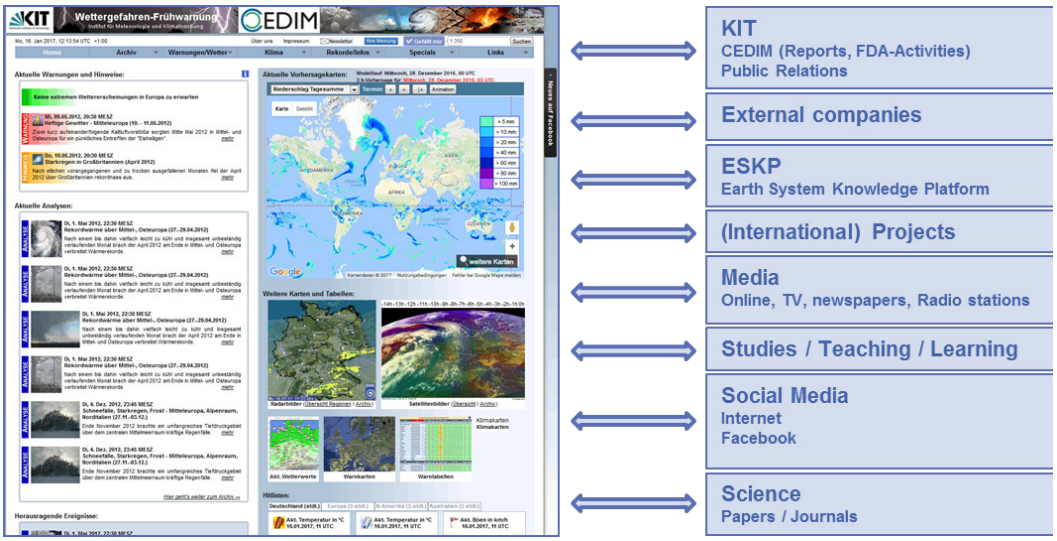

Fig. 1: Interconnections between "Wettergefahren-Frühwarnung" and different Users and Stakeholders.

The weather warnings of "Wettergefahren-Frühwarnung"

It is neither the task of "Wettergefahren-Frühwarnung" to publish detailed and minute-by-minute updated warnings nor to pronounce codes of conduct. It is the German (DWD) or other National Weather Services that are responsible for those warnings. The key aspect of "Wettergefahren-Frühwarnung" is the broader view of extreme weather events, especially when they are associated with potentially extensive damage. Textual notes about forthcoming extraordinary events are made usually a few days before their arrival and include general information on the nature of the extreme event, their intensity and their route. Typically, a short warning text supplemented by informative forecast maps, indicate the affected areas and what has to be expected. These alerts are usually updated daily. One to three days after the event a detailed editorial article finalizes the activities; these articles contain the main findings of the event and are enriched with data, maps, illustrations and figures.

Notable extreme weather events in 2016

68 extreme or unusual weather events have been investigated in the course of 2016 by Wettergefahren-Frühwarnung. Apart from hurricane Matthew in October 2016 and a series of flash floods in May/June 2016 in Germany which both required CEDIM FDA activities (see this issue), some of the extreme weather events are particularly worth mentioning:

Southern Africa experienced a summer 2015/2016 that was extremely hot and dry. Most affected were Zambia, Malawi, Zimbabwe and South Africa. According to the South African Weather Service, the year 2015 was the driest year since records began and many new all-time temperature records were set. Food prices rose and a famine became imminent for many people in southern Africa.

As a response to the strong 2015-2016 El Niño, at the beginning of May 2016 devastating forest fires developed around Fort McMurray in Alberta, Canada. 90.000 people had to flee and were evacuated in a dangerous rescue operation – the biggest evacuation from wildfires in the history of the province of Alberta. For the first time in the history of North America, a city with at least 60.000 inhabitants was surrounded by severe wildfires. The resulting damage was estimated to be above C$ 9 bn (€ 6.1 bn). At the end of November 2016 there was an extreme rain event in the western Mediterranean area. Within 5 days rain accumulation was more than 700 mm at some locations in northern Italy. In particular Piedmont and Liguria experienced extreme floods causing losses of more than € 1 bn.

Wettergefahren-Frühwarnung - part of an extensive network

Wettergefahren-Frühwarnung is not only a crucial part of CEDIM's Forensic Disaster Analysis, but is also connected with several other users, stakeholders and institutions. Data, information and advice are transferred in both directions.

Further reading:

http://www.wettergefahren-fruehwarnung.de/

Fig. 2: Screenshot taken from the archive of "Wettergefahren-Frühwarnung".

Der Webservice "Wettergefahren-Frühwarnung"

Seit dem 1. Februar 2004 informiert das Internet-Projekt „Wettergefahren-Frühwarnung“ über bevorstehende extreme oder ungewöhnliche Wetterereignisse. Zwar richtet sich der Blick auf alle Vorgänge weltweit, das Haupt-augenmerk liegt allerdings auf extreme Wetterereignisse in Mitteleuropa, vor allem, wenn sie ein großes Schadenspotential in sich bergen. „Wettergefahren-Frühwarnung“ wird unabhängig von den offiziellen Warnseiten der nationalen Wetterdienste und ohne Gewähr betrieben. Detaillierte, landkreisbezogene Warnungen, Verhaltensregeln oder Handlungshinweise an Einzelpersonen, Betriebe oder Behörden sind nicht Gegenstand der Warnungen.

Deutet sich in den Modellvorhersagen ein extremes Wetterereignis an, wird wenige Tage vor dem wahrscheinlichen Eintritt des Ereignisses eine Vorwarnung oder Warnung formuliert. In ihr wird darauf hingewiesen, welche Gebiete betroffen sein können und was auf sie zukommt. Etwa ein bis drei Tage nach dem Ereignis steht in Form eines redaktionellen Artikels eine ausführliche Analyse mit umfangreichen Informationen zur Verfügung. Das ständig wachsende Archiv umfasst bereits Analysen von mehr als 1000 extremen Wetterereignissen; im Jahr 2016 kamen 68 hinzu. Wettergefahren-Frühwarnung ist Teil des FDA Konzepts von CEDIM und steht darüber hinaus in regem Austausch mit vielen weiteren Akteuren (z.B. Medien, Forschungseinrichtungen, externe Firmen).

ATMO Forensic Prediction and Analysis - Winter Storms in Germany

Bernhard Mühr, Michael Kunz
Institute of Meteorology and Climate Research (IMK)

Overview

In Germany winter storms are responsible for a significant amount of loss and damage in respect to all natural hazards. For example, in 2007 the winter storm Kyrill caused insured losses of buildings of more than € 2 bn. Other well-known representatives of winter storms are Anatol or Lothar in 1999. In addition to the routine forecasting and analysing activities of worldwide extreme weather events within the project “Wettergefahren-Frühwarnung” (see section) a method will be developed to record, classify and evaluate winter storms in Germany with the possibility to extend the system to central or even the whole of Europe. For winter storms practical and routine methodologies will be implemented which allow an a priori and a real-time assessment of possible damage (e.g. total or insured losses) before and during a winter storm event affecting Germany.

Storm intensity and potential impact of winter storms

The intensity of a winter storm can be described by its maximum wind gusts which are recorded at stations within the network of national weather services. Another indicator is the extension of the storm’s wind field. Both storm characteristics may be combined into an easy storm index. The letters A, B, C represent the storm’s intensity (percentage of the area of entire Germany with gusts exceeding 135 kph). The extension of the storm is given by the numbers 1, 2, 3, depending on the fraction of the countries area with storm gusts of at least 75 kph.

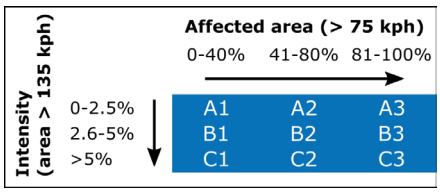

Fig. 1: Storm index matrix based on wind gust measurements (extension and intensity).

Weather stations record the wind usually with different sensor heights, and locations are often not representative of a larger area. Furthermore, the same wind speeds do not cause the same losses at various locations. Coastal or mountainous areas are prone to higher wind speeds and minor damages have to be expected. In a further step, wind gusts will be normalized by using a threshold value, e.g. the 98% quantile of maximum wind speeds during the recording period of the specific station (Klawa, 2003). By taking into account only wind gusts exceeding a given threshold value, the local wind climate at a specific site will gain particular importance.

	Kyrill	Lothar	Emma	Niklas	Egon	Gonzalo
	18.01.2007	26.12.1999	01.03.2008	31.03.2015	12./13.01.2017	22.10.2014
Affected area	Germany	Southern Germany	Germany	Germany	Central Germany	Germany
Storm Index based on measurement data	C3	C1	B3	B3	A2	A1
Area in % >= 75 kph	84.2	34.8	83.2	81.7	49.4	38.1
Area in % >= 135 kph	7.3	6.2	3.7	3.3	1.9	0.4
Average gust speed Germany	112.2	80.3	100.3	99.9	77.1	70.6
Insured losses (buildings) in millions o euros	2060	550	450	650	N.N.	< 100

Fig 2: Characteristics of some recent winter storms affecting Germany. Data source: DWD (wind data), GDV (insurance data).

Additionally, population density and (insured) values are crucial for the evaluation of the loss that might occur during a severe winter storm. Both will also be considered in future steps.

Implementing an operational forecast system for winter storms

With the availability of ensemble forecast data (e.g. Global Forecast System, GFS) both deterministic and probabilistic forecasts on incoming winter storms will be given. A storm scenario may be described well in advance and with decreasing uncertainty the closer the storm gets. Once completed and operational, the forecast system predicts the probabilities of storms, their intensities and resulting loss amount classes. Moreover, with the use of high-resolution forecast models further improvement of damage assessment may be expected at least for specific smaller regions of interest and should be verified by case studies of upcoming storm events. By validating and adjusting gust forecast data with respect to past winter storm events the forecast

Probability	Impact / Storm Index				
	Negligible A1	Minor A2 / B1	Moderate C1 / B2 / A3	Significant C2 / B3	Severe C3
1-20%	minimal	minimal	low	moderate	high
21-40%	minimal	low	low	moderate	high
41-60%	minimal	low	moderate	high	high
61-80%	minimal	low	moderate	high	extreme
81-100%	low	moderate	high	extreme	> extreme

Fig 3: Storm risk matrix based on probability of occurrence and storm index.

quality of peak wind gusts for upcoming events may be enhanced.
All data about past and future winter storm events will become part of a database. The database entries give information about individual storm events and their characteristics such as name, date of occurrence, affected regions, intensity, damage and loss. With the use of this database we can compare and search for storm events with similar or same attributes

References

Klawa, M., Ulbrich, U.: A model for the estimation of storm losses and the identification of severe winter storms in Germany, Natural Hazards and Earth System Sciences, 3, 725–732, 2003.

Atmo Forensic and Prediction Systems - Winterstürme in Deutschland

Immer wieder ziehen winterliche Sturm- oder Orkantiefs über Mitteleuropa hinweg und richten auch in Deutschland erhebliche Schäden an; mit dem besonders heftigen Orkan Kyrill im Januar 2007 erreichten die Schäden alleine an versicherten Gebäuden mehr als 2 Mrd. €. Das Schadenspotential eines Wintersturms lässt sich mit einem einfachen Index beschreiben, der die vom Sturm insgesamt betroffene Fläche und die Fläche mit extremen Orkanböen miteinander kombiniert. Dazu werden die gemessenen Spitzenböen an Stationen des Messnetzes des Deutschen Wetterdienstes herangezogen. Unterschiedliche Messhöhen sowie die große Variabilität der Repräsentativität der Messungen an den jeweiligen Standorten erfordern eine Normierung der Böendaten. Mit Hilfe aktueller und historischer Böen-Messdaten, Daten der Bevölkerungsdichte und versicherter Werte sowie Schadendaten vergangener Sturmereignisse kann ein Vorhersagesystem implementiert werden, das aktuelle Ensemble-Wind-Vorhersagedaten von Wettermodellen in eine Sturm-Risikomatrix überführt. Diese gibt Auskunft darüber, mit welcher Wahrscheinlichkeit, Intensität und daraus resultierendem Schaden bei einem sich nähernden Sturmtief in Deutschland gerechnet werden muss. Das Vorhersagesystem soll operationell betrieben werden und eine schnelle und verlässliche Schadensprognose bei Winterstürmen möglich machen.

New CEDIM Projects

Resilience of Cities in the Course of Time

Sadeeb Ottenburger, Wolfgang Raskob
Institute for Nuclear and Energy Technologies (IKET)

Introduction

It is desirable to gain a profound understanding on how disruptions of Critical Infrastructures (CIs), for example, those caused by weather events or terrorist attacks, affect the welfare of an urban area nowadays and in the future. Interdependencies of CIs may have unexpected impacts on the vulnerability of certain CIs and thus on the city as a whole. For this purpose an Agent Based Modelling (ABM) approach seems to be most promising i.e. CIs such as hospitals, pharmacies or power grid components may be modelled as agents.

Aims / Objective

The main goal is to establish a software tool based on ABM which supports decision making during a crisis as well as facilitates city planners or CI owners to design or redesign future or existing CIs, respectively, in an optimal way in the sense of robustness and mitigation.

Therefore this software tool should comprise the following key features:

- Flexible specification of disruption scenarios.
- Flexible specification of model parameters in order to define different instances of certain future trends.
- Visualization of urban resilience related quantities on the level of CIs, CI-complexes or the city as a whole.
- Dynamic options for interaction: counter measures may be implemented and evaluated during run time.

In order to achieve the main goal the following intermediate steps have to be done:

- CIs as they exist nowadays have to be modelled as agents – this also includes network and environment modelling.
- The most promising future trends related to CIs have to be identified, evaluated and if applicable modelled by, e.g., smart grid technology or car sharing
- A holistic simulation framework with a generality that allows dynamic model parametrization, dynamic specification of disruption scenarios, dynamic implementation of counter measures and a wide range of graphical tools for analysis has to be established.

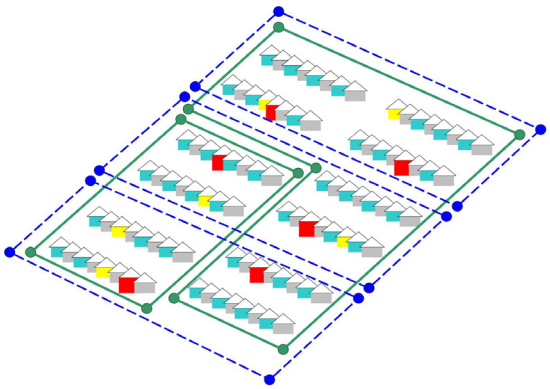

Fig.1: Two versions of smart grid installations. Red and yellow coloured buildings indicate different CI types in a segment of a city where varying sizes imply varying levels of importance of the CI type. The union of green framed and the union of blue framed areas subdividing this urban segment represent the two different kinds of smart grid decompositions.

Project status

Currently we focus on smart grid technologies - a conception of modelling topologically different smart grid instances is work in progress. A generic framework for configuring disruption scenarios and adjusting model parameters is also work in progress but partially implemented in a testing environment.

Outlook

A workshop is scheduled for January 2017 whose outcome shall be a preliminarily complete list of all basic model parameters such as: time in the year, where a simulated disruption takes place, methods for decision making, pattern of behaviour or negotiation, smart grid topology, etc.

Building and adjusting new and existing models of CIs is ongoing work: among others, hospitals and smart grids will be central topics. Environmental aspects including the simulation of urban traffic and demand for services of CIs will be included as well as models for negotiations and decision making will be evaluated and implemented.

Resilienz von Städten im Laufe der Zeit

Das Ziel des Projektes ist es, ein tiefgehendes Verständnis über die Auswirkungen von Funktionsstörungen von kritischer Infrastrukturen auf das Wohlergehen einer städtischen Umgebung zu erlangen – aus der Gegenwarts- aber auch der Zukunftsperspektive. Funktionsstörungen können z.B. durch Wetterereignisse oder Terroranschläge verursacht werden. Mithilfe agentenbasierter Simulationen, in denen kritische Infrastrukturen oder Komponenten kritischer Infrastrukturen als Agenten modelliert werden, ist es möglich, sowohl Krisenmanager Hilfe bei der Entscheidungsfindung zu geben als auch Stadtplaner und Betreiber kritischer Infrastrukturen bei der Gestaltung von kritischen Infrastrukturen zu unterstützen.

Critical Social Interactions in Case of Emergency - Vulnerability of the Chilean Street Network to Social Interaction in Case of Emergency of Natural Disasters

Susanne Kubisch, Andreas Ch. Braun
Institute of Regional Science (IfR)

Introduction

Infrastructure systems form the basis of the functioning of modern societies. If their destruction or degradation as well as their outage for a certain period of time have a significant impact on social and economic well-being as well as on national security and protection, they are termed to as critical infrastructures (CI; Attorney-General's Department, 2003). The street network of a country captures a key role in the realm of critical infrastructures, as it is important for the accessibility and therefore for the restoration, as well as the evacuation of the affected society in case of emergency (Anbazhagan et al., 2012). Due to the social relevance and in order to understand how their functionality can be affected in emergencies, the analysis of risk and vulnerability of critical infrastructures should gain more importance. It is not only the visibly increasing frequency of natural disasters in recent decades, but also the population movements and evacuation thus triggered, which may affect the functionality of the street network. Also, if social interactions in highly stressed extreme situations are characterized by large variability, we assume that they are down to structural patterns due to geographical and social constraints. Therefore, the prediction of social interactions and mobility should become crucial for effective risk management of natural disasters, as the social interactions may influence the magnitude of the impact of a natural hazard.

Aims / Objective

Due to the multiple impacts of natural disasters and their interaction between the natural and human system, the analysis of the impact of natural disasters needs an integrated approach as it forms part of a project between the Institute of Photogrammetry and Remote Sensing (IPF) and the Institute of Regional Science (IfR). This project aims to investigate the impacts of natural disasters and social interactions on the functionality of the street network in Chile.

Project status

The project is currently collecting basic information and theoretical knowledge in order to prepare the field work in Chile.

Outlook

The results of the overall project may give an important insight on the interdependencies between the natural, technological and social systems. The results can be used in order to improve risk management and reduce the vulnerability and strengthen the resilience of the street network in Chile, with a synergetic effect on the resilience of the social system.

References

Anbazhagan, P., Srinivas, S., & Chandran, D. (2012). Classification of road damage due to earthquakes. Natural Hazards(60), S. 425–460.

Attorney-General's Department. (2003). Trusted information sharing network for critical infrastructure protection. Canberra ACT: Attorney-General's department, Australian Government.

Die Auswirkungen von Naturgefahren und sozialen Interaktionen auf die Funktionalität des Straßennetzwerkes in Chile

Das integrative Projekt zwischen dem Institut für Photogrammetrie und Fernerkundung (IPF) und dem Institut für Regionalwissenschaft (IfR) untersucht die Auswirkung von Naturgefahren und sozialen Interaktionen auf die Funktionalität des Straßennetzwerkes in Chile. In dem Teilprojekt des IfR geht es speziell darum, wie und welche sozialen Interaktionen im Ereignisfall von Naturgefahren die Funktionalität des Straßennetzwerkes beeinträchtigen können. Dem Straßennetzwerk kommt als Teil kritischer Infrastrukturen eine Sonderrolle zu, da es für die Erreichbarkeit und die Restaurierung weiterer kritischer Infrastrukturen sowie für die Evakuierung im Ereignisfall von großer Bedeutung ist (Anbazhagan et al., 2012). Der Vorhersage sozialer Interaktionen und Mobilität im Ereignisfall von Naturgefahren sollte neben der Auswirkung der Naturgefahren an sich daher eine immer größere Bedeutung zukommen.

Effects of Extreme Events on EMI-Systems

Mariana Bartsch, Frank Schultmann
Institute for Industrial Production (IIP)

Christina Wisotzky, Kay Mitusch
Institute of Economics (ECON)

Introduction

Facing the increasing probability of extreme events and their potentially tremendous impacts on societies, it is imperative to investigate their impacts on current and future energy, mobility and information systems. This is also more than valid since through the interwoven character of these systems, extreme events cascade throughout. That is why natural disasters can also have severe impacts far away from their place of origin. This is aggravated by current globalization and strong inter-connectedness around the world.

Aims / Objective

This project has two subprojects: (i) to investigate the impacts of natural disasters on supply chain performance and (ii) the changed mobility behaviour of households in the aftermath of a disaster. Furthermore recommendations on supply chain design, sourcing strategies and on mobility regulations will be given.

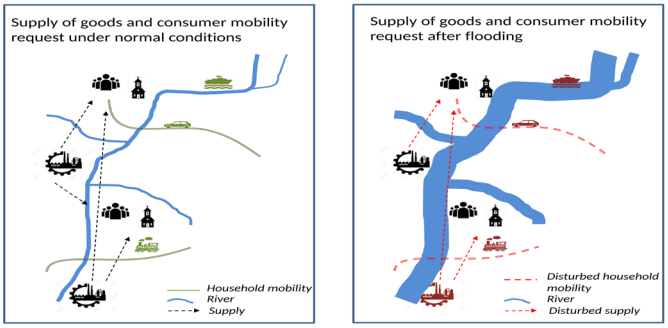

Fig.1: Possible scenario: flooding in urban regions.

Project status

Subproject 1: Effects of extreme events on supply chains

For a detailed investigation, different vulnerability drivers for a supply chain have been identified and classified according to different types of risk. The aforementioned extreme events are part of the external supply chain risks, which cannot be influenced directly by, e.g., a corporation or country. Furthermore, the vulnerability of a place or location is determined by different pre-event characteristics. Those factors can be social, economic, physical and environmental characteristics. Through an intensive literature review, these factors have been identified and a selection made regarding the topic. The next step is the formulation and implementation of the model to assess the impacts of natural disasters on supply chains and the application to defined case studies.

Subproject 2: Effects of extreme events on consumer mobility requests

From the literature review, information about general mobility behaviour and mobility behaviour during extreme events could be found, but studies dealing with mobility patterns after extreme events have not been found so far.

To understand mobility behaviour after extreme events it is crucial to examine every day mobility behaviour and mobility patterns, i.e. to first look at behaviour under normal conditions. For this, survey data from the German Mobility Panel (MOP) will be investigated with a special focus on trip purposes and modal split for specified groups of persons. In a second step, people who suffered from extreme events in the past will be interviewed or an online questionnaire will be used to gain information about changing mobility preferences.

Outlook

For both models a common sample region will be defined, where the effects on supply chains as well as on changed mobility behaviour can be demonstrated. The chosen region shall have a significant mobility demand as well as significant industry, so that impacts are substantial. In addition, a common extreme scenario has to be defined and implemented. After a current state scenario, the defined scenario shall be applied to a future city with their different needs as well as their different conditions, e.g. new forms of mobility systems. Meanwhile for each project further investigations and literature reviews will be done, leading to the formulation and implementation of models for both projects.

Die Auswirkungen extremer Naturereignisse auf EMI-Systeme

Die zu erwartende Zunahme extremer Naturereignisse und die erheblichen potenziellen Effekte für die Gesellschaft erfordern es, die Auswirkungen extremer Naturereignisse für gegenwärtige und zukünftige Energie-, Mobilitäts- und Informationssysteme zu untersuchen. Durch den Netzwerkcharakter dieser Systeme können sich Störungen und Unterbrechungen weit über den Ort einer Naturkatastrophe hinweg ausbreiten. Diese Kaskadeneffekte werden durch die starke Globalisierung und Vernetzung der Welt noch weiter verstärkt. Um diesen Aspekten Rechnung zu tragen, werden innerhalb von zwei Teilmodellen die indirekten Auswirkungen von Naturkatastrophen untersucht. Unter Berücksichtigung globale Abhängigkeiten werden zum einen die Auswirkungen von Naturkatastrophen auf Supply Chains und zum anderen die veränderte Mobilitätsnachfrage privater Haushalte nach einer Katastrophe untersucht.

Energy Risks toward 2025

James Daniell
Geophysical Institute (GPI)

Introduction

Identifying risks from natural hazards towards energy sources are a key issue moving into the future. As networks become further interconnected and optimised, the degrees of redundancy in the systems have often been reduced and shown to be vulnerable to natural perils. The increasing influence of renewable energy systems demands increasing focus on these renewable power sources.

Aims / Objective

1. Development and extension of natural disaster databases focusing on energy systems.

2. Modelling of energy systems and infrastructure damage post-disaster (PDNA style loss estimation).

3. Examination of small scale energy systems to examine the risk from natural hazards.

Project status

Currently, the project is just beginning, and resources and a literature review are being undertaken. In addition, collaborations with other groups around the world are being set up including VU Amsterdam, the University of Adelaide, Griffith University, Oxford University and the Australian National University to better understand either various perils or energy systems such as the Tesla powerwalls.

Outlook

In the near future, the development of historical loss databases for energy and infrastructure systems (earthquakes and all) will be undertaken, including a focus on geophysical risks first in order to derive preliminary loss functions for energy systems. Blackouts in 2003/2004/2006 Europe; 2003 USA; 1999/2009/2011 Brazil; 2005 Indonesia; 2001 India; 1998 New Zealand, 2011 Japan and other locations provide learning experiences for disasters in the energy sector.

For the second half of the year, the continuation of the development of loss functions will be undertaken in addition to the extension of historical energy loss database work to meteorological risks. As disasters occur, forensic disaster analyses will be undertaken into the energy systems specifically.

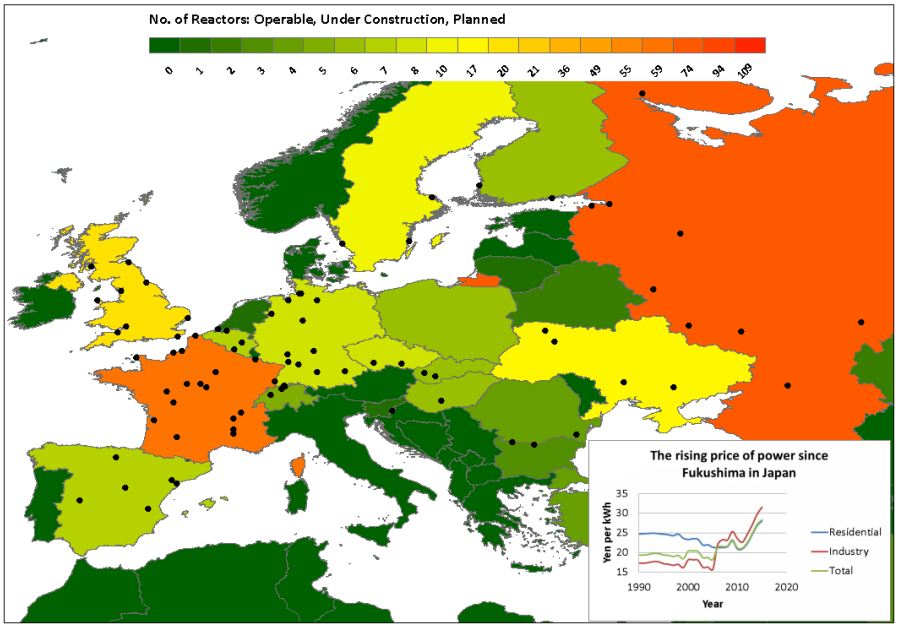

Fig.1: The rising price of power since the Fukushima disaster in Japan; and the nuclear reactors in Europe.

Energierisiken bis zum Jahr 2025

Durch die zunehmenden Abhängigkeiten und steigenden Verbindungen in optimierten Netzwerken sinkt oft die Redundanz der Energiesysteme und macht diese so anfälliger gegenüber natürliche Gefahren. Folglich steigt in Zukunft das Risiko der Energieversorgung durch Naturgefahren.

Der Fokus des Projekts liegt auf erneuerbaren Energiequellen, da diese einen wachsenden Einfluss am künftigen Energiemix haben werden. In der Projektentwicklung wurden drei Ziele definiert:

- Entwicklung und Erweiterung einer Datenbank für Naturkatastrophen mit einem Fokus auf Energiesysteme.

- Modellierung von Schäden an Energiesystemen und -infrastrukturen nach einer Katastrophe.
- Betrachtung kleinskaliger/kleiner Energiesysteme zur Untersuchung des Risikos bzgl. Naturgefahren.

In den nächsten Schritten wird die Entwicklung von historischen Datenbanken zu Schäden an Energie- und Infrastruktursystemen – zunächst bzgl. geophysikalischer Risiken – vorangetrieben. Anschließend soll der Fokus auf meteorologische Risiken erweitert werden.

Earthquake Aftershock Modelling

Andreas Schäfer, James Daniell, Friedemann Wenzel
Geophysical Institute (GPI)

Introduction

The occurrence of earthquakes is usually associated with spatial and temporal clustering, especially in the case of aftershocks, when a strong earthquake triggers several smaller ones in its vicinity. This activity is often associated with a relaxation process of the earth's crust or the activation of nearby fault systems. In many cases, aftershocks cause additional impact both in terms of socioeconomic losses but also in terms of a psychological burden arising from the fear of more earthquakes and thus hindering the ongoing recovery process.

Aims / Objective

With the quantification of potential future aftershock impacts, the psychological burden could be lowered with adequate estimates of time-dependent possible aftershock risk. Thus, a quantification scheme has been developed on the basis of aftershock occurrence statistics from the present and the past, the Aftershock Risk Index (ARI).

Project Status

Building on a previously developed earthquake cluster classification procedure, temporal occurrence parameters of past earthquake sequences have been collected and analysed. With the help of various nonlinear optimization techniques it was possible to quantify the expected number of aftershocks, e.g. for the next 24 hours. This estimate is used to compute stochastic permutations of possible aftershock occurrences. Based on various likelihood-based tests, the methodology proved its applicability in many cases and computes an easily communicable metric for the average expected aftershock impact.

Outlook

For future cases of strong-seismic sequences, the current version of the ARI can help to understand the socioeconomic impact of aftershocks on the local society. In addition, the methodology can be further tested and improved to become a frequent part of upcoming earthquake FDA activities.

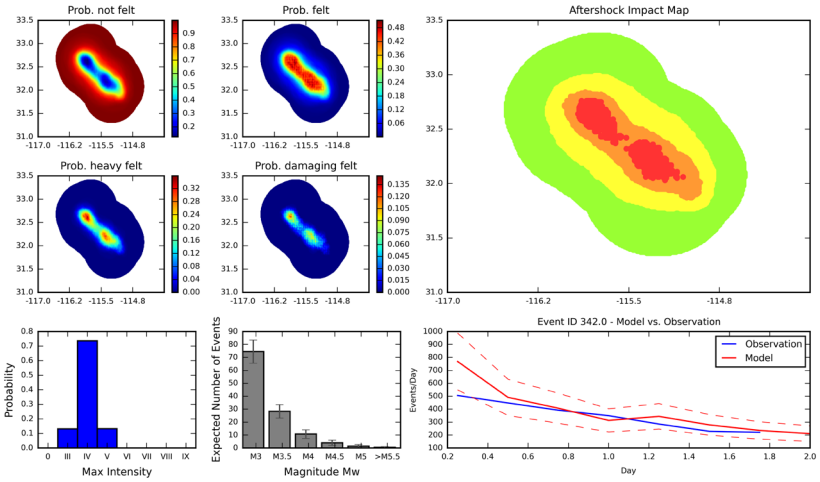

Fig.1: Example compilation of aftershock activity metrics for the 2010 Baja California earthquake, predicting the aftershock activity within 24h and 42h after the mainshock occurrence.

Nachbeben Modellierung

Im Allgemeinen treten Erdbeben räumlich und zeitlich gruppiert auf. Dies ist insbesondere dann der Fall, wenn ein starkes Hauptbeben mehrere Nachbeben in der näheren Umgebung auslöst. Nachbeben ziehen oft zusätzliche sozioökonomisch Verluste nach sich und behindern den Erholungsprozess durch die verursachte psychologische Belastung. Letzteres könnte durch eine adäquate Abschätzung des Nachbebenrisikos sowie der Quantifizierung der potentiellen Auswirkungen abgemildert werden.

Aus diesem Grund wurde unter Einbezug zeitlicher Parameter vergangener Erdbebenserien der Aftershock Risk Index (ARI) entwickelt. So kann bspw. für die folgenden 24 Stunden nach einem Erdbeben die Anzahl von Nachbeben und deren durchschnittlich zu erwarteten Auswirkungen abgeschätzt werden. Zukünftig soll diese Methode weiterentwickelt werden und regelmäßig bei Erdbeben-bezogenen FDA Aktivitäten zum Einsatz kommen.

Loss Estimation and Analysis

James Daniell, Andreas Schäfer
Geophysical Institute (GPI)

Bernhard Mühr
Institute of Meteorology and Climate Research (IMK)

Introduction

2016 was another quiet year for earthquakes but 2 or 3 main events were seen. The Kumamoto earthquakes in April caused damage likely in excess of $ 30 bn. In addition, the Muisne earthquake in Ecuador in the same month caused in excess of 600 deaths and exacted at least $ 1.5 bn in damage. The Amatrice earthquake (see separate article) caused 295 deaths in August, and then additional losses have occurred through large sequential earthquakes in October near the larger town of Norcia.

Aims / Objective

1. Rapid Loss Estimation post-disaster of socio-economic losses

2. Summary information as to hazard, exposure etc. post-disaster as part of the Forensic Disaster Analysis effort

3. Provide a link to the PDNA methodology of the World Bank and ECLAC

Project status

The project is ongoing and is carried out on an ad hoc basis as part of the Forensic Disaster Analysis project. Potentially there will be links to a new Information Portal project if possible.

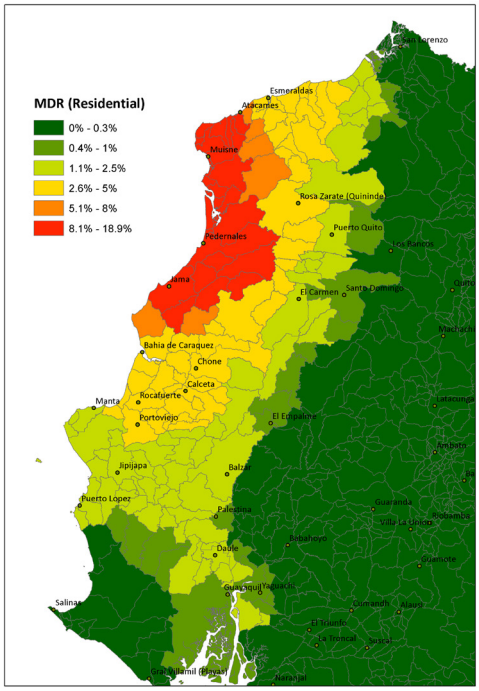

Fig.1: The MDR of the residential buildings as part of the Ecuador risk model produced as part of the rapid response effort.

The Kumamoto earthquakes were analysed in real time, with the initial Kumamoto earthquake being expected to have losses only in the order of $ 2-5 bn. However, the second shock was much stronger and closer to Kumamoto and causing more damage, giving an expected total of $ 22

bn - $ 41 bn with already weakened structures being damaged. In addition, 110 deaths occurred and the destruction of many historical landmarks.

The Taiwan earthquake in Kaohsiung in early February caused the destruction of one building which was poorly constructed through corrupt processes such as weak concrete and filling voids with old paint cans.

The Muisne earthquake in Ecuador was worked on in conjunction with a team from the World Bank, and loss analyses were undertaken. This earthquake had an interesting medium period effect where buildings around 3 to 4 storeys in Pedernales were most affected. The reconstruction was swift and many buildings were very quickly demolished. The Amatrice earthquake is written about in chapter I.

The old adage "Earthquakes don't kill people, buildings do" proved true this year.

Outlook

In the future, this work will continue as part of the "Energy Risks towards 2025" project and potentially as part of an Information Portal. In 2016, the number of fatalities was significantly lower than the average from 1900-2016 (ca. 20,000 per year). In terms of damage, the earthquake economic losses were less in absolute numbers than the normalized average since 1900 of ca. $ 90 bn per year.

Schadensabschätzung und -analyse

Im Projekt erfolgt im Nachgang zu einer Katastrophe eine schnelle Abschätzung sozioökonomischer Schäden für das betroffene Gebiet. Im Zuge einer FDA Aktivität wird darüber hinaus eine umfassende Übersichtsinformation bzgl. der Gefährdungslage erarbeitet.

Im Jahr 2016 wurden unter anderem verschiedene Erdbeben analysiert. Hier zeigte sich eine signifikant niedrigere Anzahl an Todesopfern verglichen mit dem Durchschnitt von 1900 – 2016 (ca. 20.000 pro Jahr). Auch die absoluten ökonomischen Schäden waren geringer als der normalisierte Jahresdurchschnitt seit 1900 (ca. 90 Mrd. $).

Die Arbeiten basieren auf einem ad-hoc Ansatz als Teil des Forensic Disaster Analysis und werden im neuen Projekt "Energy Risks towards 2025" fortgeführt. Des Weiteren sollen die Ergebnisse in ein Informationsportal integriert werden.

III. Cooperations and Outreach

In recent years, CEDIM researchers have collaborated with more than 50 national and international partners, such as other universities, research institutions, or companies. In the following, we briefly introduce the most important partnerships and cooperations that have continued or have been newly established over the last two years on various risk-related topics.

Research Institutions

University of Adelaide

Various overlaps between CEDIM-GPI and Adelaide have been set up with collaboration projects within BNHCRC (Bushfire and Natural Hazards CRC). In addition, various meetings have occurred in Europe and Australia; collaborations through the Australian Earthquake Engineering Society (AEES); and research papers written together. There have also been collaborations between IIP and the University of Adelaide.

Institute for Environmental Studies, VU University Amsterdam

The collaboration between CEDIM and IVM has increased greatly in the last few years with a combined EGU session on „Global and continental scale risk assessment for natural hazards: methods and practice“ and another joint session. In addition, a set of cross-cutting PhD theses and research projects are in hand at both KIT and IVM which have considerable co-supervision overlap as well as initial workshops at both Amsterdam and Karlsruhe. The complementary flood, climate change and drought studies at Amsterdam overlap well with the earthquake and meteorological foci in Karlsruhe.

Deltares

Deltares is an independent institute for applied research in the field of water and subsurface processes with five areas of expertise (flood risk, adaptive delta planning, infrastructure, water and subsoil resources, environment).
In several different projects, such as the Afghanistan multi-hazard risk assessment, open source risk software packages and ECA risk profiles, there is strong cooperation with Deltares. Among the various outputs are joint research papers and abstracts, as well as EGU sessions that are part of the extended research.

Insurance Industry

Willis Research Network (WRN)

CEDIM has been a member of the Willis Research Network (WRN) since 2009, a network of excellence funded by the global insurance broker Willis (renamed in 2016 as Willis Towers Watson). WRN cooperates with CEDIM by funding a Willis fellow (full position) in the working group “At-

mospheric Risks" (IMK-TRO) on the topic of hail risk modeling.
WRN provides an open forum for the advancement of the science of extreme events through close collaboration between highly-ranked universities, insurers, reinsurers, catastrophe modelling companies, government research institutions and non-governmental organizations. As the only German partner of the network, CEDIM researchers gather experience in the cooperation with the insurance industry and learn about their needs and research priorities.
Within a flagship project, CEDIM has developed a unique method to identify and characterize hail events using a satellite processing algorithm in cooperation with NASA. The resultant Willis Re European Hail Model (WEHM), covering 34 European countries, is applied by several insurance companies to estimate hail risk for property, motor and agricultural portfolios. Building on the success of WEHM, the model is now being adjusted and applied to other hail-prone regions of the world such as Australia.

References

Punge, H.J. and M. Kunz, 2016: Hail observations and hailstorm characteristics in Europe: A review. Atmos Res., 176–177, 159–184, doi: 10.1016/j.atmosres.2016.02.012

Punge, H.J., K. Bedka, M. Kunz, and A. Werner, 2014: A new physically based stochastic event catalog for hail in Europe. Nat. Hazards, 73, 1625-1645. DOI 10.1007/s11069-014-1161-0.

WRN, 2016: The Research Network: The Science of Managing Extremes.
http://www.willis.com/willisresearchnetwork/flagship_project/FlagBook/index.html

Sparkassenversicherung SV

In the project HARIS-SV (Hail Risk SV), CEDIM / IMK-TRO have developed a novel hail risk model for the SV Sparkassenversicherung insurance company. The model estimates the probable maximum loss from a 200-year event (PML200) that insurers need to provide in the context of the regulatory directive Solvency II. The hail risk model can also be applied to quantify damage from single events. It is based on several thousands of footprints from past hailstorms in Germany estimated from radar reflectivity from the German Weather Service (DWD) radar network. The stochastic event set is created from polygons that are randomly constructed from the radar-derived event set. In the last year, the hail model was further improved and calibrated by considering adjusted hail-size distributions and different damage functions based on loss experiences from past hailstorms. The HARIS-SV project ended in January 2017, but will continue on a reduced basis in the future.

Within the cooperative project FLORIS-SV (Flood Risk SV), CEDIM aims at estimating damage related to widespread extreme flood scenarios based on stochastic modelling of precipitation processes and resulting floods. A special focus is put on events that occur more or less simultaneously in different catchment areas, thus leading to extreme loss situations. Precipitation and related return periods are quantified based on stochastically generated precipitation fields. These fields are obtained from a linear combination of orographic, background, convective and frontal rain. Hydrological modelling for different catchments allows relationships to be established between rainfall and runoff. Probable maximum loss (PML) for different return periods is estimated from SV portfolio data in combination with modelled inundation areas. Involved in the project are IMK-TRO (Working group Atmospheric Risks), IWG (Department of Water Resources Management and Rural Engineering), and James E. Daniell.

References

Puskeiler, M., M. Kunz and M. Schmidberger, 2016: Hail statistics over Germany derived from single-polarization Radar Data. Atmos. Res., 178-179, 459-470, doi:10.1016/j.atmosres.2016.04.014

Kunz, M., and P.S.I. Kugel, 2015: Detection of hail signatures from single-polarization C-band Radar Reflectivity. Atmos. Res., 153, 565-577. doi:10.1016/j.atmosres.2014.09.010

International Programs

IRDR International Center of Excellence

Since 2012, CEDIM has been cooperating with the program Integrated Research on Disaster Risk (IRDR, www.irdrinternational.org), an initiative of the International Council for Science (ICSU), the International Social Science Council (ISSC) and the United Nations International Strategy for Disaster Reduction (UNISDR). The IRDR Forensic Investigations of Disasters (FORIN) project proposes an approach that aims to uncover the root causes of disasters through in-depth investigations that go beyond the typical reports and case studies conducted post-disaster events. With its focus on near real-time disaster analysis to identify major risk drivers, CEDIM's FDA research activity is complementary to IRDR's more long-term analysis.
In June 2015, a new IRDR International Centre of Excellence (ICoE) on Critical Infrastructures and Strategic Planning was established in Germany as a network hub between the Institute of Spatial and Regional Planning (IREUS; Prof. J. Birkmann, leader), University of Stuttgart, CEDIM, the United Nations University in Bonn, and the University of Potsdam. This ICoE will support integrated research on the resilience of critical infrastructures, their management and the increasing dependency of societies on the functioning of critical infrastructures. In October 2015, CEDIM researchers were invited to a DFG roundtable at IREUS to discuss and identify open research questions on the topic of integrated research for enhancing the resilience of critical infrastructures through strategic assessments and innovative planning approaches and to develop a framework for future research and cooperation activities.

WMO's High Impact Weather Project HIWeather

In 2016, the World Meteorological Organization (WMO), part of the United Nations, launched a new 10-year World Weather Research Program on High Impact Weather events (HIWeather). The overall objective of HIWeather is to build resilience to a wide range of selected weather-related hazards through research and its application in key aspects of meteorology, hazard prediction, human impacts, warnings communication and evaluation. CEDIM (M. Kunz) is member of the Human Impacts, Vulnerability and Risk Task Team. During the kick-off meeting at UK Met Office in April 2016, where CEDIM presented its FDA approach, specific activities for the future, possible cooperations, and specific stakeholder needs and how they can be satisfied were discussed.

CEDIM and the World Bank & GFDRR (Global Facility for Disaster Reduction and Recovery)

GFDRR
Global Facility for Disaster Reduction and Recovery

Over the past few years as part of the Forensic Disaster Analysis work and their research, a natural overlap has occurred with the interests of the World Bank and CEDIM Researchers (J. Daniell and A. Schaefer). Various projects including:

- Review of open source global natural disaster risk modelling software (https://www.gfdrr.org/sites/gfdrr/files/publication/UR-Software_Review-Web_Version-rev-1.1.pdf);
- A risk assessment study for Eastern Europe and Central Asia (33 countries) for earthquake and floods (https://openknowledge.worldbank.org/handle/10986/25858);
- Disaster risk profiles for over 12 countries in Latin America and the Caribbean for earthquakes and tropical cyclones;
- Rapid post-disaster assessment of losses for inidividual earthquakes, such as those in Nepal 2015, Ecuador and Haiti 2016;
- The Afghanistan Multi-Hazard Risk Assessment (F. Wenzel, B. Khazai & volunteers) in cooperation with Deltares, ENEA and GRF Davos.

GADRI

In 2016, CEDIM became a member of the Global Alliance of Disaster Research Institutes (GADRI). Inaugurated in March 2015, GADRI is a collaborative platform for discussion, sharing knowledge and promoting networks on topics related to disaster risk reduction and resilience to disasters. This program is embedded into The Sendai Framework for Disaster Risk Reduction 2015-2030 of the United Nations Office for Disaster Risk Reduction (UNISDR). CEDIM participated with an active role at both the 2nd Global Summit of Research Institutes for Disaster Risk Reduction in March 2015 at Kyoto University, and the 1st GADRI General Assembly in March 2017.

Spin-Off Company Risklayer

The new spin-off Risklayer (www.risklayer.com) is an independent think tank established in 2016 and based in Karlsruhe. The Risklayer team originates from within CEDIM as well as the General Sir John Monash Foundation in Australia. Risklayer's staff are also involved in intense academic and governmental research, teaching and training activities with various universities including KIT, which allow Risklayer to remain at the cutting edge of scientific and technical solutions. Risklayer aims to provide tailor-made services and practical solutions for their clients to help them uncover short- and long-term risks and build disaster resilience.

Outreach

European Geosciences Union (EGU)

Since the foundation of CEDIM, its members have been and are still actively contributing on the annual General Assembly of the European Geosciences Union (EGU).

"CEDIM" session and special issue

In recent years the assembly featured a dedicated session to the core research fields of CEDIM. In 2017 the session was renamed "Natural hazard event analyses for risk reduction and adaptation" and is co-convened by CEDIM members. In addition, the submissions to this year's session will be published in a special issue of the open-access journal "Natural Hazards and Earth System Sciences (NHESS)" featuring the CEDIM spokesman Michael Kunz as one of the editors.

CATDAT goes global at the EGU 2016

In the news, disaster statistics are commonly reported as isolated figures, placed into context by the tragic human costs of floods, earthquakes and droughts. In order to be able to provide a more holistic perspective, James Daniell has over several years compiled a database that includes all natural perils, for the first time globally. In addition to his regular talk at the EGU General Assembly in April 2016, he was an invited speaker to the EGU press conference on the topic "Impacts and costs of natural hazards".
Over 50,000 events make up the database with at least 34,000 damaging events since 1900 sourced from over 90 languages. Up to $7 trillion worth of economic losses have occurred globally since 1900. This value was revealed by comparing economic costs for various natural disasters including floods, earthquakes, volcanoes, storms and droughts using a collection of socio-economic indicators called the CATDAT Damaging Natural Disaster database. Of this $7 trillion, most of financial costs have been from flooding disasters, which accounted for around 40% of losses. Since the 1960's, however, this trend has started to shift, with storms and storm surges accounting for 30% of the losses. In terms of fatalities (8 million+ deaths globally since 1900), earthquakes have caused the highest percentage

since 1950. By combining the data for disasters reported between 1900 and 2015, interesting trends in vulnerability across the globe are revealed. Although absolute losses are increasing, relative losses proportionate to the global economy seem to be quite constant or even decreasing, depending on the peril looked at. In terms of fatalities these are reasonably constant versus the global death rate, with a decrease versus the global population.
In the fortnight following the EGU, over 800 newspaper articles, TV spots, science reports in over 40 languages in more than 70 countries reported upon the article including the BBC (http://www.bbc.com/news/science-environment-36078527) and "Der Spiegel". (http://www.spiegel.de/wissenschaft/natur/acht-millionen-tote-durch-naturkatastrophen-seit-1900-a-1087842.html).

Outstanding ECS Award

At the 2017 EGU General Assembly, James Daniell will be awarded the "Outstanding Early Career Scientist Award" from the Natural Hazards Division for his distinguished scientific achievements in the field of natural hazards.

Earth System Knowledge Platform ESKP

The Earth System Knowledge Platform (ESKP) is part of the Helmholtz-Association's Portfolio process in the Research Field Earth and Environment coordinated by the Helmholtz Centre Potsdam GFZ. Via the ESKP webpage (www.eskp.de), CEDIM disseminates the main results and outcomes of the FDA activities to the public and several stakeholders. With its expertise on natural hazards and risks, and in particular with the current focus on Forensic Disaster Analysis in near real-time, CEDIM is an important partner for ESKP.

Media Presence (Television, Radio, Print)

CEDIM researchers are esteemed experts for regional, national and international media such as TV, radio and print media. On several different events in the past two years their evaluation and assessment comments were in high demand.
Numerous appearances on TV shows, interviews on radio shows and citations in newspapers and news portals, exhibit the wide range of visibility of CEDIM's work. Among the TV appearances were well-known and popular national and regional formats such as:

- "[W] wie Wissen" on ARD with the topic "Wasserflut und Hagelschlag";
- "planet e." on ZDF with the topic "Hagel, Fluten, Wirbelwinde - Wetterchaos in Deutschland";
- "SWR extra" on SWR with the topic "Unwetterkatastrophe – Der Tag danach";
- "odysso - Wissen im SWR"on SWR with the topic "Wetterkatastrophen";
- "Im Gespräch" on Baden TV featuring the CEDIM members James Daniell and Andreas Schäfer in an interview with focus on earthquake and tsunami risk modelling;

Another highlight that shows CEDIM's high profile, is the full page article/infographic that appeared on 3 March 2016 in the weekly newspaper „Die Zeit" with an estimated 2 million readers. For the 5-year anniversary of the Fukushima disaster, statistics on the changes in Fukushima Province with respect to power prices, radiation, employment, indirect deaths, population and housing changes as well as other socioeconomic issues in various sectors such as tourism were analyzed. The non-exhaustive list of broadcasting stations, news agencies and newspapers that quoted CEDIM or reported on work or members of CEDIM shows that also on an international level CEDIM is extremely visible.

- ABC
- Al Jazeera
- ARD
- Arte
- BBC
- BR
- DER SPIEGEL
- DIE ZEIT
- Discovery Channel
- Frankfurter Allgemeine
- HR
- L'OBS
- MDR
- ORF
- Pro Sieben
- Russia Today
- Scientific American
- Sky news
- Stern
- SWR
- The Japan Times
- The New York Times
- ZDF

FDA and Short Reports

During the last two years the Forensic Disaster Analysis Task Force has published near real-time reports on seven different disasters; among them were four earthquakes two thunderstorm events and one hurricane (see Section II.). To some extent these activities included several updates as well as different foci for follow-up reports and scientific papers. Forty-one different authors from five different institutes within the KIT and six external organizations worked jointly on these reports.

CEDIM at "The Change Agenda" Symposium in Oxford, England

As part of his John Monash Award work, James Daniell represented CEDIM at the inaugural John Monash Scholars' Symposium held at Oxford University, England, from 31 March to 1st April 2016, discussing topics such as natural disasters, refugee crises, economics, small scale wall batteries and quantum computing. The attendees collaborate on projects, white papers and reports throughout the year that provide advice to the Australian government as well as other global entities on climate change, technology shifts and unique research. The attendees were from Uni. Cambridge, Uni. Oxford, UCL, KIT (CEDIM), University of Paris, University of Copenhagen, ETH Zurich, London School of Economics, University of Amsterdam, the Australian and UK Governments, various industry partners such as Commonwealth Bank, and other companies. A Collaboration on energy systems losses via the natural hazards project was negotiated with some attendees as well as with institutions back in Australia.

Networking Initiative at KIT

Strategic Workshops on „Risks, Catastrophes and Security"

Various institutes at KIT conduct high-level research on Risks, Catastrophes, and Security, enabling high visibility at national and international levels. So far, however, there is no aligned cross-linking and networking strategy among the different disciplines, KIT-Centers, and KIT-Divisions on those topics. An improved networking is considered necessary by a large number of researchers to better address the challenges that arise from societal changes such as the energy turnaround or the decisions of the UN World Climate Conference COP21 in Paris 2015 for security and risk research. CEDIM, together with the KIT-Center Climate and Environment, has therefore started a process to improve the cross-linking of the various research activities at KIT and to develop a common strategy. In 2016, two workshops were set up, which serve as kinds of nuclei for the foreseen networking strategy. Based on the presentations and discussions during these workshops, a topic paper will be compiled presenting and highlighting the common research at KIT in the field of Risks, Catastrophes, and Security.

James Daniell at the press conference at the EGU General Assembly on the topic „Impacts and costs of natural hazards".

Strategic workshop at KIT on the topics of „Risk, Catastrophe and Security" on 8 December 2016.

CEDIM at the "Wissenschaftsfestival" EFFEKTE on 27 June 2015.

CEDIM expert team in Nepal to investigate the effects of the Gorkha earthquake on 25 April 2015.

James Daniell during a field trip in Braunsbach, Germany, after the severe flashflood on 29 May 2016.

CEDIM spokesman Michael Kunz in the ZDF science show „planet e." as expert for severe convective storms.

IV. Publications 2015 and 2016

Articles in Journals and Books 2015

Anhorn J. & Khazai B. (2015): Open Space Suitability Analysis for Emergency Shelter after an Earthquake, Nat. Hazards Earth Syst. Sci., 15, 789-803, doi:10.5194/nhess-15-789-2015

Brauner F., Münzberg T., Wiens M., Fiedrich F., Lechleuthner A., Schultmann F. (2015): Critical Infrastructure Resilience: A Framework for Considering Micro and Macro Observation Levels, Proceedings of the 12th International Conference on Information Systems for Crisis Response and Management, 24-27

Daniell, J.E. (2015): "Global View of Seismic Code and Building Practice Factors", Michael Beer, Edoardo Patelli, Ioannis Kougioumtzoglou and Ivan Siu-Kui Au (Eds.) in "Encyclopaedia of Earthquake Engineering". Springer.

Daniell, J.E. (2015): "The Evolving Risk of Earthquakes: Past, Present, and Future", eds. Stuart Fraser, upcoming book: Evolving Risk, World Bank Press, in publication.

Dittrich A., Richter D., Lucas C. (2015): "Analysing the Usage of Spatial Prepositions in Short Messages", eds. Gartner G. & Huang H., Springer International Publishing, Cham, 153-169.

Fohringer J., Dransch D., Kreibich H., Schröter K. (2015): Social Media as an Information Source for Rapid Flood Inundation Mapping, Nat. Hazards Earth Syst. Sci., 15, 2725–2738, doi:10.5194/nhess-15-2725-2015

Goda K., Wenzel F., De Risi R. (2015): Empirical Assessment of Nonlinear Seismic Demand of Mainshock-Aftershock Ground Motion Sequences for Japanese Earthquakes, Front. Built Environ. 1:6. doi: 10.3389/fbuil.2015.00006

Gunasekera, R., Ishizawa, O., Aubrecht, C., Blankespoor, B., Murray, S., Pomonis, A., & Daniell, J.E. (2015): "Developing an adaptive global exposure model to support the generation of country disaster risk profiles", Earth-Science Reviews, 150, 594-608.

Khazai B., Anhorn J., Girard T., Brink S., Jimee G.K., Parajuli B., Wagle S., Khanal O. (2015): "Emergent Issues and Vulnerability Factors in Temporary and Intermediate Shelters Following the 2015 Nepal Earthquake", International Journal for Mass Emergencies and Disasters, submitted January 2016 (Manuscript in review).

Kunz M., P.S.I. Kugel (2015): Detection of Hail Signatures from Single-Polarization C-Band Radar Reflectivity, Atmos. Res., 153, 565-577. doi:10.1016/j.atmosres.2014.09.010

Mohr S., Kunz M., Geyer B. (2015): Hail Potential in Europe Based on a Regional Climate Model Hindcast, Geophys. Geophys. Res. Lett., 42, doi:10.1002/2015GL067118

Mohr S., Kunz M., Keuler K. (2015): Development and Application of a Logistic Model to Estimate the Past and Future Hail Potential in Germany, J. Geophys. Res., 120, 3939-3956. 10.1002/2014JD022959

Müller T., Meng S., Raskob W., Wiens M., Schultmann, F. (2015): A Transparent Approach for Prioritising Security Measures, Beyerer, J. (Eds.) Security Research Conference: 10th Future Security Conference, Berlin, September 15-17, 2015 Proceedings, 217-224

Münzberg T., Wiens M., Raskob W., Schultmann F. (2015): Measuring Resilience - The Benefits of an Empirical Study of Power Outages by Media Data, 10th Future Security Conference 2015, Berlin, September 15-17, 2015, Proceedings, 393 – 400

Münzberg T., Wiens M., Schultmann F. (2015): The Effect of Coping Capacity Depletion on Critical Infrastructure Resilience, Proceedings of the 12th International Conference on Information Systems for Crisis Response and Management, L. Palen, M. Buscher, T. Comes, and A. Hughes, eds.

Raskob W., Bertsch V., Ruppert M., Strittmatter M., Happe L., Broadnax B., Wandler S., Deines E. (2015): Security of Electricity Supply in 2030, Critical Infrastructure Protection and Resilience Europe (CIPRE) Conference & Expo, The Hague, the Netherlands.

Raskob W., Wandler S., Deines E. (2015): Agent-based Modelling to Identify Possible Measures in Case of Critical Infrastructure Disruption, Proceedings of the 12th International Conference on Information Systems for Crisis Response and Management, L. Palen, M. Buscher, T. Comes, and A. Hughes, eds.

Schröter K., Kunz M., Elmer F., Mühr B., Merz B. (2015): What made the June 2013 flood in Germany an exceptional event? A hydro-meteorological evaluation, Hydrol. Earth Syst. Sci., 19, 309-327, doi: 10.5194/hess-19-309-2015

Sokolov V., Wenzel F. (2015): On the Relation between Point-Wise and Multiple-Location Probabilistic Seismic Hazard Assessments, Bulletin of Earthquake Engineering, 13, 5, 1281-1301

Articles in Journals and Books 2016

Daniell J.E., Kron A., Brand J., Muehr B., Vecere A., Piper D., Kunz M., Ehmele F., Mohr S.: Exceptional sequence of severe thunderstorms and related flash floods in May and June 2016 in Germany – Part 2: Hydrology and Damage Assessment, Nat. Hazards Earth Syst. Sci., 17 (in preparation)

Girard T., Kämpf C. (submitted September 2016): A Semiotic-Process Model to Enhance the Communication of Disaster Response Information. Int. J. of Mass Emergencies and Disasters.

Kunz-Plapp T., Hackenbruch J., Schipper J.W. (2016): Factors of Subjective Heat Stress of Urban Citizens in Contexts of Everyday Life, Natural Hazards and Earth Systems Sciences, 16, 977-994, doi:10.5194/nhess-16-977-2016

Münzberg T., Wiens M., Schultman F. (2016): Understanding Resilience: A Spatio-temporal Vulnerability Assessment of a Population affected by Sudden Lack of Food, Springer International Series in Operations Research & Management Science: Advances in Managing Humanitarian Operations, 235, 257-280

Piper D., Kunz M., Ehmele F., Mohr S., Mühr B., Kron A. & Daniell J. (2016): Exceptional sequence of severe thunderstorms and related flash floods in May and June 2016 in Germany – Part 1: Meteorological background, Natural Hazards and Earth System Sciences 16(12), 2835-2850

Punge H.J., Kunz M. (2016): Hail Observations and Hailstorm Characteristics in Europe: A review, Atmos Res., 176-177, 159-184, doi: 10.1016/j.atmosres.2016.02.012

Puskeiler, M., Kunz M., Schmidberger M. (2016): Hail statistics over Germany derived from single-polarization Radar Data, Atmos. Res., 178-179, 459-470, doi:10.1016/j.atmosres.2016.04.014

Richter A., Ruck B., Mohr S. & Kunz M. (2016): Interaction of Severe Convective Gusts and Typical Urban Structures, Urban Climate, in print, http://dx.doi.org/10.1016/j.uclim.2016.11.003

Thieken A.H., Bessel T., Kienzler S., Kreibich H., Müller M., Pisi S., Schröter K. (2016): The flood of June 2013 in Germany: how much do we know about its impacts?, Nat. Hazards Earth Syst. Sci. 16, 1519-1540; doi:10.5194/nhess-16-1519-2016

Thieken A.H., Kienzler S., Kreibich H., Kuhlicke C., Kunz M., Mühr B., Müller M., Otto A., Petrow T., Pisi S., Schröter K. (2016): Review of the flood risk management system in Germany after the major flood in 2013, Ecology & Society 21(2): 51, DOI: http://dx.doi.org/10.5751/ES-08547-210251

Tsang Hing-Ho, Wenzel F. (2016): Setting Structural Safety Requirement for Controlling Earthquake Mortaility Risk, Safety Science, 86, 174-183

Wagner Th., Goda K., Erdik M., Daniell J., Wenzel F. (2016): A Spatial Correlation Model of Peak Ground Acceleration and Response Spectra Based on Data of the Istanbul Earthquake Rapid Response and Early Warning System, Soil Dynamics and Earthquake Engineering, in print

Conference Abstracts 2015

Daniell, J.E., Schäfer, A., Wenzel F. (2015A): "A tail of eight cities: earthquake scenario risk assessment for major Australian cities", Australian Earthquake Engineering Society Conference, Sydney, Australia.

Daniell, J.E., Schäfer, A., Wenzel, F. (2015B): "The value of life in earthquakes and other natural disasters: historical costs and the benefits of investing in life safety", Australian Earthquake Engineering Society Conference, Sydney, Australia.

Daniell, J.E., Schaefer, A.M., Wenzel, F. (2015): "What is the best use of 100 Euros to reduce the earthquake risk of a residential masonry building in a developed nation? Optimisation and Quantification of the benefits of risk reduction", EGU General Assembly Conference Abstracts, 17, 1881.

Daniell, J.E., Kunz-Plapp, Tina, Schaefer, A.M., Wenzel, F., Khazai, B. (2015): "What is the cost of a life in a disaster?-Examples, Practice and Global Analysis", EGU General Assembly Conference Abstracts, 17, 1882.

Daniell, J.E., Simpson, A., Gunasekara, R., Baca, A.l, Schaefer, A.M., Ishizawa, O., Murnane, R., Tijssen, A., Deparday, V., Forni, M. (2015): "Global review of open access risk assessment software packages valid for global or continental scale analysis", EGU General Assembly Conference Abstracts, 17, 1889.

Daniell, J.E., Schaefer, A.M., Toro, J., Murnane, R., Tijssen, A., Simpson, A., Saito, K., Winsemius, H., Ward, P. (2015): "A stochastic risk assessment for Eastern Europe and Central Asian countries for earthquakes", EGU General Assembly Conference Abstracts, 17, 1886.

Daniell, J.E., Skapski, J.-U., Vervaeck, A., Wenzel, F., Schaefer, A.M. (2015): "Global Earthquake and Volcanic Eruption Economic losses and costs from 1900-2014: 115 years of the CATDAT database-Trends, Normalisation and Visualisation", EGU General Assembly Conference Abstracts, 17, 8119.

Dittrich A., Vasardani M., Winter S., Baldwin T. & Liu F. (2015): A Classification Schema for Fast Disambiguation of Spatial Prepositions, in 'Proceedings of the 6th ACM SIGSPATIAL International Workshop on GeoStreaming', ACM, New York, NY, USA, 78-86.

Schäfer A.M., Daniell, J.E., Wenzel F. (2015A): "The seismic hazard of Australia - a venture into an uncertain future", Proceedings of the Tenth Pacific Conference on Earthquake Engineering, Building an Earthquake-Resilient Pacific, Sydney, Australia.

Schäfer A.M., Daniell, J.E., Wenzel F. (2015B): "M9 returns – towards a probabilistic Pan-Pacific Tsunami Risk Model", Proceedings of the Tenth Pacific Conference on Earthquake Engineering, Building an Earthquake-Resilient Pacific, Sydney, Australia.

Schaefer, A.M., Daniell, J.E., Wenzel, F. (2015): "Earthquake Forecasting Methodology Catalogue-A collection and comparison of the state-of-the-art in earthquake forecasting and prediction methodologies", EGU General Assembly Conference Abstracts, 17, 5346

Schaefer, A.M., Daniell, J.E., Wenzel, F. (2015): "Present, Past, Future-What earthquake clusters can tell us about an upcoming Marmara Sea earthquake", EGU General Assembly Conference Abstracts, 17, 5314.

Schaefer, A.M., Daniell, J.E., Wenzel, F. (2015): "The Asia-Pacific effects of a Megatsunami along the Tonga Trench", EGU General Assembly Conference Abstracts, 17, 5284.

Schaefer, A.M., Daniell, J.E., Wenzel, F. (2015): "Earthquake Cluster Analysis for Turkey and its Application for Seismic Hazard Assessment", EGU Gen. Assem. Conf. Abstracts, 17, 5301.

Schaefer, A.M., Daniell, J.E., Wenzel, F. (2015): "State-of-the-Art in Tsunami Risk Modelling for a global perspective", EGU General Assembly Conference Abstracts, 17, 5239.

Schmidt H.-M., Wiens M., Schultmann F. (2015): Industrial Vulnerability against Climate Change Impacts – An indicator-Based Analysis for Germany and the Stuttgart Metropolitan Area. The 5thWorld Sustainability Forum, Basel, 2015.

Schmidt H-M., Wiens M., Schultmann F. (2015): Models for Regionalizing Economic Data and their Applications within the Scope of Forensic Disaster Analyses. Poster session at the European Union General Assembly 2015, Vienna.

Conference Abstracts 2016

Arnst, I., Wenzel, F., Daniell, J.E. (2016): Trends in global earthquake loss, EGU General Assembly Conference Abstracts, 18, 1812.

Girard T. (2016): "Information Seeking and Communication Behavior of Communities Affected by the 25 April 2015 Gorkha Earthquake in Nepal", Proc. of International Conference on Earthquake Engineering and Post Disaster Reconstruction Planning in Bhaktapur, Nepal.

Daniell, J.E., Daniell, T.M. (2016): Updated Risk Indices in the Asia-Pacific Region for Earthquakes and Floods, CECAR7 Conference, Honolulu, HI.

Daniell, J.E., Wenzel, F., Werner, A., Schäfer, A.M., Tsang, H-H. (2016): An introduction of tools for evaluating the influence of building codes on the level of earthquake fatalities globally, 24th Australasian Conference on the Mechanics of Structures and Materials, Perth, Australia.

Daniell, J.E., Wenzel, F., McLennan, A., Daniell, K., Kunz-Plapp, T., Khazai, B., Schaefer, A., Kunz, M., Girard, T. (2016): The global role of natural disaster fatalities in decision-making: statistics, trends and analysis from 116 years of disaster data compared to fatality rates from other causes, EGU General Assembly Conference Abstracts, 18, 2021.

Daniell, J.E., Wenzel, F., Schaefer, A.M. (2016): The economic costs of natural disasters globally from 1900-2015: historical and normalised floods, storms, earthquakes, volcanoes, bushfires, drought and other disasters, EGU General Assembly Conference Abstracts, 18, 1899.

Daniell, J.E., Schäfer, A.M., Wenzel, F. (2016): The historical socioeconomic cost of earthquakes vs. other natural disasters types globally – an argument for greater funding for research and prevention, Australian Earthquake Engineering Conference 2016, Melbourne, Australia.

Daniell, J.E., Daniell, T.M., Daniell, K.A., Khazai, B., Schaefer, A., Wenzel, F. (2016): A continuation of the Asia-Pacific Risk Index for natural disasters: extending the record for an updated analysis from 1900-2015, EGU General Assembly Conference Abstracts, 18, 1901.

Daniell, J.E., Schaefer, A.M., Wenzel, F., Khazai, B., Girard, T., Kunz-Plapp, T., Kunz, M., Muehr, B. (2016): The costs and benefits of reconstruction options in Nepal using the CEDIM FDA modelled and empirical analysis following the 2015 earthquake, EGU General Assembly Conference Abstracts, 18, 1900.

Düzgün H.S., Wenzel F., Aydin N.Y. (2016): "Assessment of Critical Infrastructure Vulnerabilities due to Cascading Impacts of Multiple Natural Hazards: A Conceptual Framework for Earthquake Triggered Landslides", Proc. of International Conference on Earthquake Engineering and Post Disaster Reconstruction Planning in Bhaktapur, Nepal.

Schaefer, A.M., Daniell, J.E., Wenzel, F. (2016): Development of a global tsunami source database – initial results, EGU General Assembly Conference Abstracts, 18, 7847.

Schaefer, A.M., Daniell, J.E., Wenzel, F. (2016): The SMART CLUSTER METHOD – adaptive earthquake cluster analysis and declustering, EGU General Assembly Conference Abstracts, 18, 7830.

Schaefer, A.M., Daniell, J.E., Khazai, B., Wenzel, F. (2016): The Aftershock Risk Index – quantification of aftershock impacts during ongoing strong-seismic sequences, EGU General Assembly Conference Abstracts, 18, 7719.

Schaefer, A.M., Daniell, J.E., Mazengarb, C., Rigby, E., Wenzel, F. (2016): The Tsunami Risk of South-East Tasmania, Australia – the impact of the Puysegur Trench on greater Hobart, EGU General Assembly Conference Abstracts, 18, 7807.

Tsang, H-H., Wenzel, F., Daniell, J.E. (2016): Are Our Buildings Safe Enough for Controlling Earthquake Mortality Risk?, EGU General Assembly Conference Abstracts, 18, 1809.

Wagener, T., Goda, K., Erdik, M., Daniell, J.E., Wenzel, F. (2016): A Spatial Correlation Model of Peak Ground Acceleration and Response Spectra Based on Data of the Istanbul Earthquake Rapid Response and Early Warning System, EGU General Assembly Conference Abstracts, 18, 1810.

Wenzel, F., Leder, J., Daniell, J.E., Gottschämmer, E. (2016): Loss to residential buildings by a re-eruption of the Laacher See Volcano, EGU General Assembly Conference Abstracts, 18, 2016.

CEDIM Reports 2015

Daniell J.E., Khazai B., Power C. (2015): Earthquake Vulnerability Indicators for the Determination of Indirect Loss Potential. CEDIM, 73p.

Daniell J.E. et al. (2015): "Nepal Earthquake – Report #1", 27.04.2015, Nepal Report No. 1, 20p.

Daniell J.E. et al. (2015): "Nepal Earthquake – Report #3", 13.05.2015, Nepal Report No. 3, 26p.

Khazai B., Anhorn J., Girard T., Brink S., Daniell J.E., Bessel T., Mühr B., Flörchinger V., Kunz-Plapp T. (2015): "Shelter response and vulnerability of displaced populations in the April 25, 2015 Nepal Earthquake.", Nepal Report No. 2.

CEDIM Reports 2016

Daniell J.E., Pomonis A., Schaefer A.M., Vervaeck A., Gunasekera R., Ishizawa O., Skapski J-U., Mühr B., Wenzel F., Dittrich A. (2016): Amatrice Earthquake, 26.08.2016 – Situation Report No. 1 – 16:00 GMT, CEDIM FDA short report.

Mühr B., Daniell J.E., Wisotzky C., Wandel J., Becker F., Buchholz M., Baumstark S., Schäfer A.M., Dittrich A. (2016): Hurricane Matthew - 24 October 2016 – Report No. 1 – Update, CEDIM FDA report.

Mühr B., Daniell J.E., Ehmele F., Kron A., Dittrich A., Kunz M. (2016): High water/flooding Southern Germany May/June 2016 20 June 2016, CEDIM FDA Report.

Mühr B., Becker F., Kunz-Plapp T., Kunz M. (2015): Central European extreme rain events 19th to 21st November 2015 - Report No 1, 23rd November 2015

Schäfer M., Daniell J., Wenzel F., Pomonis A., Mühr B. (2015): Greece Earthquake 17 November 2015 – Report No 1, 17.11.2015 – Situation Report No. 1

Schäfer M., Daniell J., Wenzel F., Vervaeck A. (2015): Chile Earthquake 16 Sep 2015 – Report No 1, 17.09.2015 – Situation Report No. 1 – 05:30 GMT

Contact
CEDIM Head Office
Hermann-von-Helmholtz-Platz 1
76344 Eggenstein-Leopoldshafen
info@cedim.de

100 % recycled paper with the quality label „Der Blaue Engel"

Issued by CEDIM

www.cedim.de