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CEDIM

Annual Research Report 2014
Focus on Forensic Disaster Analysis in Near Real-Time

Enhancing Resilience by Learning from Disasters

Content

Preface

2014 was a relatively quiet year in terms of the occurrence of major natural disasters. In particular, regarding earthquake disasters, that year belongs to the longest period of quiescence since 1900, over two and a half years since the last major event. "Less than" 850 deaths and "only" around 6770 injuries have been counted in 30 death-bearing and 87 casuality-bearing earthquakes according to the CATDAT database to which CEDIM is contributing. As a consequence, CEDIM put its focus in 2014 more on the development of methods for the rapid analysis of catastrophes rather than on the forensic disaster analysis (FDA) itself in event triggered task force activities.

Nevertheless, two damaging events that occurred in 2014 were still investigated by CEDIM within the frame of their FDA activities. These were the Iquique (Pisagua) earthquake of April 1st in Northern Chile, with MW=8,2 the strongest earthquake in this area since 137 years and the super typhoon Hagupit that threatened the Philippines in the same region which typhoon Haiyan had devastated only one year before. Although both events, due to the relatively little damage and losses incurred, did not match CEDIM's criteria for a full FDA activity, short FDA reports were published.
(1) The Iquique earthquake was of special interest for CEDIM, because, despite the size of the earthquake, it had only released a small fraction of the energy estimated to be stored in the subduction zone of the region, suggesting that in the future there is still the potential for a considerably larger event.
(2) Protective measures before landfall of super typhoon Hagupit had also attracted CEDIM's interest. They were considered a best practice example, because the relatively low number of fatalities and the lower storm damage than previously feared was not only due to the decrease of the storms intensity before landfall, but to a great extent to the early and effective evacuation of more than 700.000 people.

Considerable progress has been made in the development of methods for earthquake disaster analysis in near real-time. This includes the ability of automatically imaging earthquake rupture processes from GPS and strong motion seismograms. The method has been finalized and published in 2014. The progress also includes the finalization of socio-economic fragility functions for use in world-wide rapid earthquake loss estimation procedures, and in particular the design of a social fragility function that estimates the number of displaced people after an earthquake. In addition, first steps were made to combine CEDIM's rapid post-disaster analysis methodology with indicator methods to provide post-disaster vulnerability locations in combination with loss estimates.

With regard to atmospheric extreme events, CEDIM has put special emphasize in 2014 in the development of a system to predict in near real-time the severity of a storm in Germany in terms of loss and possible fatalities. The system is based on three indicators reflecting the wind speed, the affected area and the storm intensity, as well as the damage, total loss and fatalities. It is expected to become operational by the end of 2015. In addition, CEDIM has taken up again the problem of hail risk in Germany and has further developed in 2014 the ability of assessing not only the hazard but also the risk coming from hail. Given the result that there are strong indications suggesting an increase in the hail potential in Europe over past and future decades, damage from hail may become more and more important in Germany.

Like in the field of atmospheric extreme events CEDIM's 2014 development activities in the area of flooding also had a regional focus in Germany. This involved the design of a novel approach for assessing flood risk in river catchments at large spatial scales (>10.000 km^2) and in a spatially consistent way. The approach was developed by CEDIM in 2014 for the mesoscale catchment of the Mulde river (≈ 6.000 km^2) and has great potential to be transferred to other mesoscales of even large-scale catchments It is currently being implemented for case studies in the Saale catchment and the German part of the Elbe catchment. With regard to a rapid flood event analysis in Germany the most important progress in 2014 has been the implementation of CEDIM´s flood event analysis approach in a database system which automatically retrieves and stores data from more than 100 online discharge gauges on a daily basis. Initiated by experiences coming from the flood in June 2013 in Germany, the system is currently being further developed for rapidly mapping inundated areas and inundated depths, including data provided by social media.

CEDIM is aware of the growing importance of social media with regard to providing information on the impact of natural extreme events. As before, the advancement of methods that make use of crowdsourcing for rapid damage assessment has, therefore, been a major concern of CEDIM's activities also in 2014. Consequently, the above mentioned capability of derivating inundation depths from photos that were combined with tweets has been further strengthened in the year. The capability is part of CEDIM´s software package TENAS (Twitter Event Notification and Analysis Service), which by now monitors geo-referenced disaster related Twitter messages in real-time, on a worldwide 20 km x 20 km grid, 24 hours a day, and in more than 40 languages.

Closely related to this is CEDIM's attempt to develop a user-oriented visualization platform. This work started in 2014 and aims as a first step at designing a prototype platform as a Weblog for event based information in near real-time. The envisaged format covers not only text and static figures, but also interactive maps, picture galleries and videos.

As in the years before, CEDIM in 2014 also addressed a wide range of disaster related risks for critical infrastructure. These included the risks and crisis management of food supply interruptions in Germany, in particular business interruptions related to food supply, as well as vulnerability and risks for health care and water supply due to power interruptions. The potential influence of climate change on the industry in Baden-Württemberg has also been a subject of these research activities, as well as cyber-risks, economic crime and risks to public rail transport systems due to terrorist threats. All of these investigations aim at contributing to the development of more efficient decision support methods that aid decision makers from different administrative levels of disaster and emergency management. Central to these activities two expert workshops with end-users were organized in 2014, one with a more general focus on the evaluation and management of risks, the other addressing management planning for food shortages and power outages at the local level.

Strategic partnerships have always been an essential component of CEDIM's work. These partnerships have been extremely active in 2014. In the case of the Global Earthquake Model (GEM), for instance, the cooperation resulted in the first rigorous quantitative and comparative test of US earthquake hazard models, which helps to improve these hazard models over time. The testing of risk models is starting now. In the frame of the Willis Research Network of the global insurance broker Willis, CEDIM also contributed to the Social Vulnerability and Integrated Risk Program of GEM. This contribution was completed by the end of 2014 and resulted in the development of multiple comprehensive spatially enabled databases for building indicators and indices of social and economic vulnerability that are integrated with GEM's Open Quake Platform. A special toolkit has been developed in collaboration with the GEM Modelling Facility that allows users to access the global and sub-national databases on the Open Quake platform for the building of social, economic or integrated risk indices. In addition, a multi-level risk and resilience scorecard has been developed in collaboration with GEM and implemented as a self-evaluation tool with both ward level and municipal representatives from Lalitpur (Nepal) in March 2014.

Besides cooperation with Willis in the frame of GEM, CEDIM in a close collaboration with the Willis CatNet team also contributed in 2014 to the improvement of the hazard component of the Willis European Hailmodel WEHM which estimates frequency, extent and severity of hail events. Hail modelling has also been an object of cooperation between CEDIM and the Sparkassenversicherung SV in 2014. In this collaboration, CEDIM is developing a novel and unique hail risk model for Germany based on a combination of radar, lightning and insurance loss data. One specific goal is the ability to estimate overall losses from hail in near real-time. As a new activity of the cooperation with the Sparkassenversicherung SV, the development of a tool for damage estimations related to widespread extreme flood scenarios was started in 2014.

Bilateral cooperations have also been enhanced in 2014 with ESKP, the "Earth System Knowledge Platform" of the Helmholtz-Association, IRDR, the "Integrated Research on Disaster Risk Program" of ICSU, ISSC and UNISDR as well as with alpS, the Centre for Climate Change Adaptation in Innsbruck, Austria. In addition, stakeholder interactions for near real-time forensic analysis of disasters have been advanced in 2014 with various organizations within both public and private sectors. These interactions aimed at identifying research fields of common interest.

The year 2014 has been an extremely active one with regard to CEDIM's work. The various scientific results were published in 34 articles in journals and books, 38 conference abstracts and six CEDIM reports related to the years damaging events. We would like to sincerely thank all those who contributed to the results and express our hope and best wishes for successfully carrying on the CEDIM idea into the coming years.

Jochen Zschau

Vorwort

Mit Blick auf die Naturkatastrophen war 2014 ein relativ ruhiges Jahr. Dies trifft besonders für Erdbebenkatastrophen zu, für die 2014 zu der längsten Ruhephase seit 1900 gehört. Mehr als zweieinhalb Jahre waren Ende des Jahres seit dem letzten großen Ereignis vergangen. Nach der CATDAT-Datenbank, zu der CEDIM beiträgt, gab es 2014 „weniger" als 850 Todesopfer und „nur" etwa 6770 Verletzte in 177 Erdbebenereignissen, in denen Tote und / oder Verletzte zu beklagen waren. CEDIM´s Fokus lag daher 2014 vorwiegend auf methodischen Entwicklungen zur schnellen Analyse unmittelbar nach Katastrophenereignissen und weniger auf den Ereignis getriggerten forensischen Katastrophenanalysen (FDA) selbst.

Dennoch gab es 2014 zwei Schadenereignisse, die von CEDIM in Nahe-Echtzeit analysiert wurden: das Iquique- (Pisagua) -Erdbeben vom 1. April 2014 in Nordchile, das mit einer Momentenmagnitude von 8,2 das stärkste Beben in der Region seit 137 Jahren war, und der Supertaifun Hagupit, der dieselbe Gegend auf den Philippinen bedrohte, die ein Jahr zuvor von Taifun Haiyan verwüstet worden war. Beide Ereignisse (Iquique-Beben und Hagupit) erfüllten eigentlich nicht die CEDIM-Kriterien für einen vollen FDA-Einsatz, waren jedoch wissenschaftlich interessant genug, um einen begrenzten FDA-Einsatz mit einem jeweils kürzeren FDA-Report zu rechtfertigen.
(1) Das Iquique-Erdbeben war von besonderem Interesse für CEDIM, denn trotz der Größe des Erdbebens war es nur ein kleiner Bruchteil der schätzungsweise in der Subduktionszone der Region gespeicherten Energie, die hier durch das Beben freigesetzt worden war. Das deutet darauf hin, dass es in der Zukunft noch das Potential für ein wesentlich größeres Ereignis gibt.
(2) Insbesondere hatten auch die Schutzmaßnahmen vor dem Landgang von Supertaifun Hagupit das Interesse von CEDIM geweckt. Sie gelten als ein „Best-Practice"-Beispiel, weil die relativ geringe Zahl der Todesopfer und die kleineren Sturmschäden als vorab befürchtet nicht nur die Folge der Abnahme der Sturmintensität vor dem Landgang waren, sondern zu einem großen Teil auch auf die frühzeitige und effektive Evakuierung von über 700.000 Menschen zurückzuführen waren.

Erhebliche Fortschritte sind bei der Entwicklung von Methoden zur Erdbebenkatastrophenanalyse in Nahe-Echtzeit gemacht worden. Dies schließt die Fähigkeit zum automatischen Abbilden von Erdbeben-Bruchprozessen durch GPS und Strong-Motion-Seismogramme ein. Das Verfahren wurde 2014 abgeschlossen und veröffentlicht. Der Fortschritt betrifft auch die Fertigstellung von sozio-ökonomischen Fragilitätsfunktionen für den Einsatz bei weltweiten schnellen Abschätzungen von Erdbebenverlusten, insbesondere auch den Aufbau einer sozialen Fragilitätsfunktion, die Bevölkerungsverschiebungen nach einem Erdbeben abschätzt.

Im Hinblick auf extreme Wetterereignisse hat CEDIM im Jahr 2014 besonderen Wert auf die Entwicklung eines Systems gelegt, das in Nahe-Echtzeit die Schwere eines Sturms in Deutschland prognostiziert, in Bezug auf den Schaden und mögliche Todesfälle. Das System basiert auf drei Indikatoren, die die Windgeschwindigkeit, die betroffene Region und die Sturmintensität, sowie die Schäden, den Totalverlust und die Todesfälle wiederspiegeln. Ende 2015 soll es einsatzfähig sein. Auch das Problem Hagelrisiko in Deutschland wurde von CEDIM 2014 wieder aufgegriffen mit dem Ziel, nicht nur die Gefährdung, sondern auch die durch Hagel entstehenden Risiken abzuschätzen. Angesichts der starken Anzeichen für eine Erhöhung des Hagelpotenzials in Europa über die vergangenen und zukünftigen Jahrzehnte, können Hagelschäden in Deutschland an Bedeutung gewinnen.

Wie bei den extremen Wetterereignissen hatten auch CEDIM´s Entwicklungsaktivitäten im Bereich Hochwasser im Jahr 2014 einen regionalen Schwerpunkt in Deutschland. Er betraf die Bewertung des Hochwasserrisikos in großen Flusseinzugsgebieten (>10.000 km^2). Ein neuer Ansatz hierzu wurde von CEDIM im Jahr 2014 für das mesoskalige Einzugsgebiet der Mulde (≈ 6.000 km^2) entwickelt, mit einem guten Potenzial, auch auf größere Flusseinzugsgebiete wie beispielsweise die Elbe (148.000 km²) erfolgreich angewendet zu werden. Mit Blick auf eine schnelle Hochwasserereignisanalyse in Deutschland war ein wichtiger Fortschritt im Jahr 2014 die Implementierung des CEDIM-Hochwasser-Analyseverfahrens in ein Datenbanksystem, das

täglich und automatisch Daten von mehr als 100 Online-Pegelstationen abruft, speichert und hinsichtlich der statistischen Wiederkehrintervalle und der räumlichen Ausprägung bewertet. Angeregt durch Erfahrungen aus der Analyse des Hochwassers im Juni 2013 in Deutschland, wird das System aktuell für eine schnelle Kartierung von Überflutungsflächen und -tiefen weiterentwickelt. Dafür werden unterschiedliche Datenquellen wie beispielsweise Wasserstandsmessungen an Pegeln, Fernerkundungsdaten, aber auch Fotos und Informationen aus sozialen Medien erfasst und zu einem Gesamtbild zusammengeführt.

CEDIM ist sich der wachsenden Bedeutung der sozialen Medien für die schnelle Sammlung von Informationen über die Auswirkungen von natürlichen Extremereignissen bewusst. Wie schon zuvor war deshalb auch im Jahr 2014 die Weiterentwicklung von Methoden, die „Crowdsourcing" zur schnellen Schadensbewertung nutzen, ein wichtiges Anliegen. Daher wurde die oben erwähnte Fähigkeit zur Ableitung von Überschwemmungstiefen aus Fotos, die mit Tweets kombiniert werden, in CEDIM´s Softwarepaket TENAS (Twitter Ereignisbenachrichtigung und Analyse Service) integriert. TENAS überwacht jetzt geo-referenzierte und Katastrophen bezogene Twitter-Nachrichten in Echtzeit, auf einem weltweiten 20 km x 20 km-Raster, 24 Stunden am Tag und in über 40 Sprachen.

Eng verknüpft mit diesen Aktivitäten ist CEDIM´s Versuch, eine anwenderorientierte Visualisierungsplattform zu entwickeln. Diese Arbeit begann im Jahr 2014 und zielt im ersten Schritt darauf ab, eine Prototyp-Plattform im Weblog-Format für ereignisbasierte Daten in Nahe-Echtzeit zu gestalten. Das vorgesehene Format beinhaltet neben Textpassagen und statischen Abbildungen auch interaktive Karten, Bildergalerien und Videos.

Wie in den Jahren zuvor, hat sich CEDIM auch im Jahr 2014 mit einer breiten Palette von Katastrophenrisiken für kritische Infrastrukturen befasst. Dazu gehörten die Risiken und das Krisenmanagement von Unterbrechungen der Lebensmittelversorgung in Deutschland, insbesondere damit zusammenhängende Betriebsunterbrechungen, sowie Vulnerabilität und Risiken für das Gesundheitswesen und die Wasserversorgung aufgrund von Stromunterbrechungen. Ein potenzieller Einfluss des Klimawandels auf die Industrie in Baden-Württemberg war ebenfalls Gegenstand dieser

Forschungsarbeiten, wie auch Cyber-Risiken, Wirtschaftskriminalität und Risiken für den öffentlichen Schienenverkehr durch terroristische Bedrohungen. Alle diese Untersuchungen sollen einen Beitrag zur Entwicklung von effizienteren Entscheidungsunterstützungsmethoden für Entscheidungsträger aus den verschiedenen Verwaltungsebenen von Katastrophen- und Notfallmanagement leisten. Im Mittelpunkt der Aktivitäten hierzu standen zwei Experten-Workshops. Sie wurden mit Endnutzern organisiert, einer mit einem allgemeineren Fokus auf der Bewertung und dem Management von Risiken, der andere mehr spezifisch zum Management von Nahrungsmittelknappheit und Stromausfällen auf lokaler Ebene.

Strategische Partnerschaften sind seit jeher ein wesentlicher Bestandteil der Arbeit im CEDIM. Diese Partnerschaften waren in 2014 besonders aktiv. Im Falle des Global Earthquake Model (GEM) zum Beispiel, entstanden aus der partnerschaftlichen Zusammenarbeit erste quantitative und vergleichende Tests der US-Erdbebengefährdungsmodelle, die dabei helfen, diese Gefährdungsmodelle zu verbessern. Die Prüfung von Risikomodellen beginnt gegenwärtig.

Im Rahmen des Willis Research Network des globalen Versicherungsmaklers Willis, hat CEDIM zu dem „Social Vulnerability- und Integrated Risk-Programm" von GEM beigetragen. Dieser Beitrag wurde zum Ende 2014 abgeschlossen und führte zur Entwicklung mehrerer raumbezogener Datenbanken für den Aufbau von Indikatoren sozialer und wirtschaftlicher Vulnerabilität. Sie wurden in GEM´s Open Quake-Plattform integriert. Ein spezielles Toolkit, welches auf die globalen und regionalen Datenbanken der Open Quake-Plattform zurückgreifen lässt, wenn es um die Erstellung sozialer, ökonomischer oder integrierter Risikoindikatoren geht, konnte in Zusammenarbeit mit der „GEM-Modelling-Facility" bereitgestellt werden. Ebenfalls in Zusammenarbeit mit GEM wurde darüber hinaus eine mehrschichtige Risiko- und Resilienz-Punktekarte (Scorecard) erarbeitet und im März 2014 als Selbstbewertungsinstrument am Beispiel von Lalitpur (Nepal), sowohl auf Bezirksebene als auch auf städtischer Ebene, mit entsprechenden administrativen Vertretern getestet und eingeführt.

Neben der Zusammenarbeit mit Willis im Rahmen von GEM hat CEDIM 2014 auch direkt mit

dem Willis CatNet-Team kooperiert, und zwar zur Verbesserung der Hazard-Komponente des europäischen Willis-Hagelmodells WEHM, welches Häufigkeit, Ausmaß und Schwere von Hagelereignissen abschätzt. Hagelmodellierung war auch Gegenstand der Zusammenarbeit zwischen CEDIM und der Sparkassenversicherung SV 2014. In dieser Kooperation entwickelt CEDIM ein neues Hagel-Risikomodell für Deutschland, das sich besonders in seiner Kombination von Radar, Blitzschlag und Versicherungsschadensdaten fundamental von vorangegangenen unterscheidet. Ein konkretes Ziel ist, die Gesamtverluste durch Hagel in Nahe-Echtzeit abschätzen zu können. Als eine neue Aktivität der Zusammenarbeit mit der Sparkassenversicherung SV hat die Entwicklung eines Tools zu Schadensschätzungen für großräumige extreme Hochwasserereignisse begonnen.

Zu den bilateralen Kooperationen in 2014 zählen auch diejenigen mit ESKP, der „Earth System Knowledge Platform" der Helmholtz-Gemeinschaft, mit IRDR, dem „Integrated Research on Disaster Risk"-Programm der ICSU, ISSC und UNISDR sowie mit alpS, dem Zentrum für Klimawandelanpassung in Innsbruck, Österreich. Darüber hinaus sind wichtige Stakeholder-Interaktionen im Zusammenhang mit forensischen Analysen von Katastrophen in Nahe-Echtzeit fortgesetzt worden. Diese Stakeholder-Interaktionen mit Organisationen sowohl im öffentlichen als auch im privaten Sektor dienten der Identifikation von Forschungsfeldern, denen gemeinsames Interesse gilt.

Das Jahr 2014 war für CEDIM ein äußerst aktives Jahr. Die zahlreichen wissenschaftlichen Ergebnisse wurden in 34 Artikeln in Zeitschriften und Büchern, in 38 Konferenzbeiträgen und in sechs CEDIM-Berichten zu Schadenereignissen des Jahres veröffentlicht. Wir möchten uns bei allen herzlich bedanken, die zu den Ergebnissen beigetragen haben, und bringen unsere Hoffnung und die besten Wünsche für eine erfolgreiche Weiterführung der CEDIM-Idee in den kommenden Jahren zum Ausdruck.

Jochen Zschau

I. Research

FDA Research Projects

Rapid Assessment of Slip Distribution

Andreas Höchner
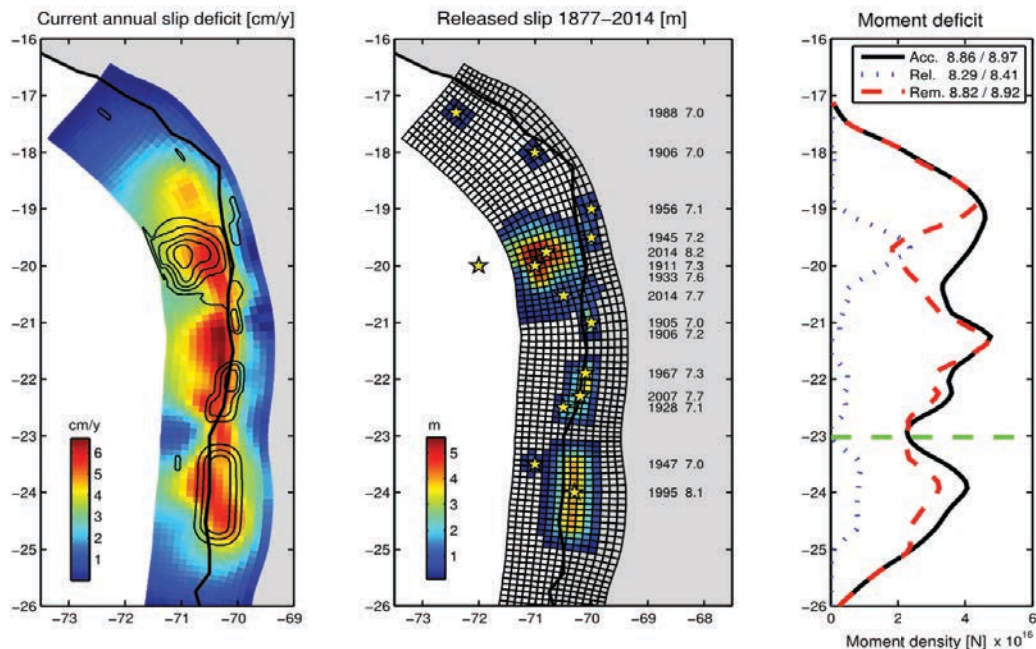
Fig. 1: Seismic moment budget in northern Chile. The black line in the right panel shows the estimated accumulated moment since 1877 as a function of latitude, the blue line which has been released by earthquakes, and the red line that is expected to still be present.

Introduction

During recent decades, and especially since the advent of GNSS (Global Navigation Satellite System), geodetic methods have become more prominent in supporting traditional seismological methods. In the near field of large earthquakes, data from broadband seismometers and accelerometers are not straight forward to interpret as ground displacement due to clipping and tilting artefacts, while displacement time series from GNSS receivers are still stable. Having observations as close to the source as possible enables faster estimation of earthquake magnitude. The direct relationship between slip at the rupture fault and displacement at the observing station allows good assessment of the slip distribution and, in the case of subduction events, for sea floor defor-

mation, which is crucial information for tsunami early warning.

Aims/Objective

The goal of the project is the development of fast and stable methods using near field displacement time series from GNSS and accelerometers to infer slip distribution of large earthquakes in near real time. In the case of subduction earthquakes, a semi-automatic processing should be possible since the geometry of the fault can be assumed to be given by the subduction plate interface. For other events, geometric information has to be obtained by seismological methods or geological analyses and thus manual processing is necessary.

Fig. 2: Tsunami hazard Makran. Shown are probabilities of exceeding certain coastal water height levels somewhere in the Makran region (Iran, Pakistan) for different time periods.

Project status

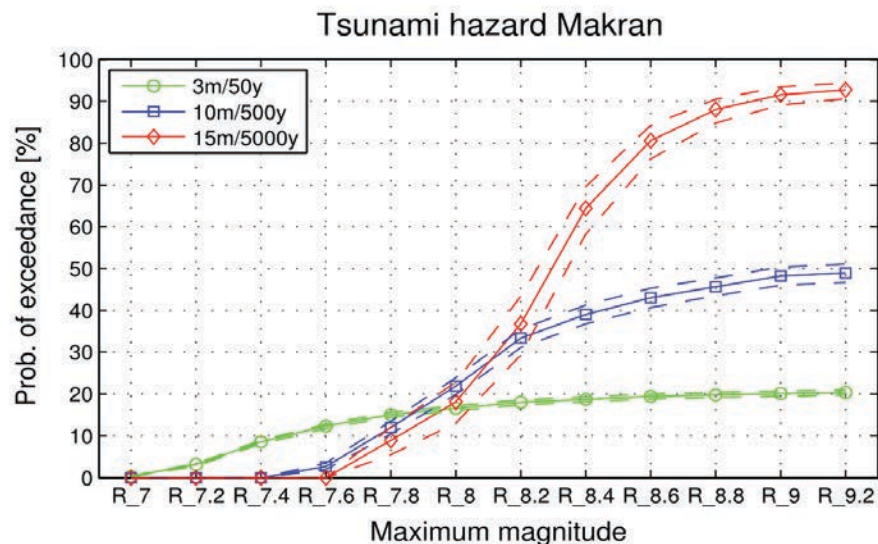A wave-form inversion method (Iterative Deconvolution and Stacking, IDS) working with broadband-, accelerometer- and GPS-data was developed and published [Zhang et al. 2014]. Application to coseismic signals from the Pisagua earthquake in 2014 shows promising results with very high spatial and temporal resolution of rupture propagation imaging.

During last year, there were no earthquakes having such an impact as to trigger a CEDIM forensic disaster analysis (FDA) activity. However, a large event, the Pisagua earthquake with magnitude Mw=8.2 occured offshore Chile, which was of great scientific interest, since it took place in the so-called Northern Chile seismic gap. This region has been monitored closely in anticipation of a possible gap-closing event. Analysis of the data from this event at GFZ led to a publication in "Nature" with contributions from CEDIM members [Schurr et al. 2014]. One significant conclusion is that the Pisagua-earthquake released only a rather small fraction of the moment which is assumed to have been accumulated in the region and other large events are still likely to happen. This result was also presented at the AGU fall meeting in San Francisco [Hoechner et al. 2014].

A tsunami hazard assessment for the Makran region was made and presented at the AGU fall meeting [Zamora et al. 2014]. Of special interest is the consideration of recent findings sug-

gesting larger maximum magnitude than previously assumed for this subduction zone.

Outlook

The IDS method will be developed further for automatic or semi-automatic processing similar to a moment tensor inversion.

The Makran hazard assessment will be published as a paper.

Core Science Team

Andreas Hoechner
Stefano Parolai
Rongjiang Wang
Jochen Zschau
 *GFZ, Section 2.1, Physics of Earthquakes
 and Volcanoes*

Publications

Hoechner A., Bedford J, Moreno M., Hainzl S., Dahm T. (2014): Coupling at the Northern Chile seismic gap and moment balance after the Mw=8.2 Pisagua event 2014, AGU fall meeting S33E-03

Schurr B., Asch G., Hainzl S., Bedford J., Hoechner A., Palo M., Wang R., Moreno M., Bartsch M., Zhang Y., Oncken O., Tilmann F., Dahm T., Victor P., Barrientos S., Vilotte J.-P. (2014): Gradual unlocking of plate boundary controlled initiation of the 2014 Iquique earthquake, Nature, doi:10.1038/nature13681

Zamora N., Hoechner A., Babeyko A. (2014): Probabilistic tsunami hazard assessment for Makran considering recently suggested larger maximum magnitudes and sensitivity analysis for GNSS-based early warning, AGU fall meeting, S21A-4394

Zhang Y., Wang R., Zschau J., Chen Y., Parolai S., Dahm T. (2014): Automatic imaging of earthquake rupture processes by iterative deconvolution and stacking of high-rate GPS and strong motion seismograms, Journal of Geophysical Research, doi: 10.1002/2013JB010469

Slipverteilung

Die Entwicklung von Methoden zur hochpräzisen Prozessierung von GNSS-Daten in Nahe-Echtzeit macht diese interessant als Ergänzung traditioneller seismologischer Verfahren. Besonders im Nahfeld großer Beben ist es damit möglich, eine genauere und raschere Bestimmung der Slipverteilung, d.h. der relativen Plattenverschiebung während eines Erdbebens durchzuführen. Dies ist insbesondere für die Tsunami-Frühwarnung wichtig. Ziel des Projekts ist die Entwicklung einer schnellen und stabilen Inversionsmethode, um aus GNSS- und Accelerometer-Zeitreihen die Slipverteilung zu bestimmen. Eine solche Methode wurde entwickelt und veröffentlicht [Zhang et al. 2014]. 2014 wurden keine Erdbeben-FDA-Aktivitäten ausgelöst, aber die Analyse von Daten des Pisagua-Bebens am GFZ führte zu einer "Nature"-Publikation mit CEDIM-Beteiligung [Schurr et al. 2014]. Ein wesentliches Resultat, nämlich dass obiges Beben nur einen Teil der Spannung abgebaut hat, und dass weitere große Beben wahrscheinlich sind, wurde am AGU-Herbsttreffen präsentiert [Hoechner et al. 2014]. Eine Studie zur Tsunami-Gefährdung in der Makran-Region wurde ebenfalls an der AGU gezeigt.

Loss Assessment for Earthquakes

James Daniell, Friedemann Wenzel, Bijan Khazai, Tina Kunz-Plapp, Chris Power, Susan Brink, Trevor Girard, Andreas Schaefer

Introduction

Worldwide, for each damaging earthquake that occured last year, full reports have been created of the potential impacts, analysis of the losses and rapid estimates of fatalities, damaged buildings and economic losses. The assessment of various components of hazard, vulnerability and exposure, combined with the socioeconomic climate of the affected region, allows for successful estimation of losses: specific indices have also been created.

Aims/Objective

- To determine which events are interesting and are historically significant for forensic disaster analysis.
- To create a rapid loss estimate of the potential impacts, and to look at the evolution and key parameters which influence the earthquake losses.
- To create robust methodologies using socio-economic indicators and traditional empirical and analytical fragility functions.
- The creation of indicators to aid post-disaster vulnerability analysis.

Project status

In conjunction with www.earthquake-report.com in order to provide the quickest possible information via a group of dedicated 24/7 reporting, loss estimation methodologies have been used in various studies in 2014.

In cooperation with Jens-Udo Skapski from Bochum University, and Armand Vervaeck from Belgium, the disaster database reveals over 380 damaging earthquakes as well as 10 rock-
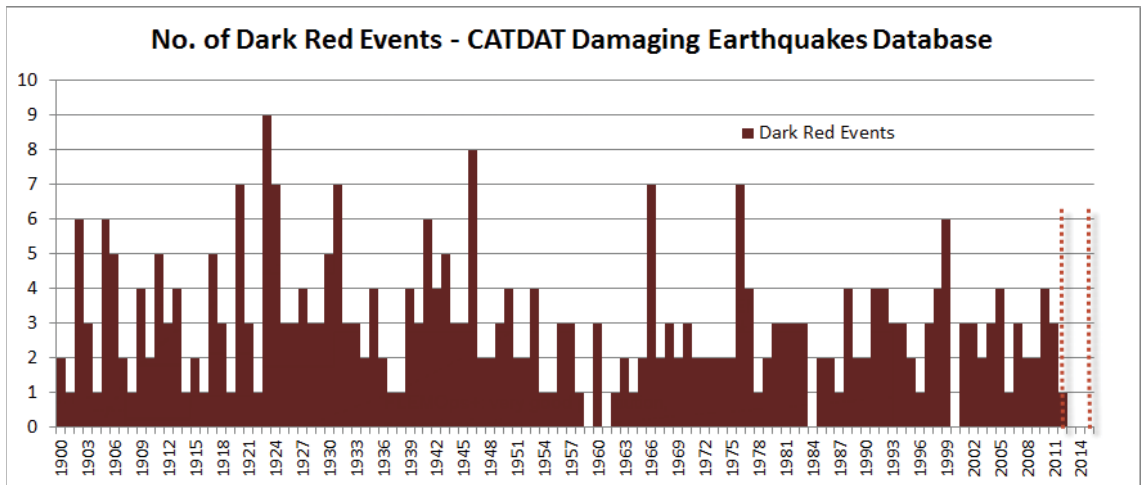
Fig. 1: The period of quiescence in terms of Dark Red rated CATDAT events.

bursts, with around 200 that have been classified as having damage significant enough to be input into the yearly review of damaging earthquakes via CATDAT. So far, 823-837 deaths, and around 6770 injuries have been counted in 30 death-bearing and 87 casualty-bearing earthquakes.

Although a number of events have been analysed, none of the hard-wired forensic disaster analysis criteria has been exceeded as yet. In May 2012, there was one such event – the Mirandola earthquake (subject to the final loss estimate) with around $17 billion reconstruction costs estimated. Follow-up for all events has been undertaken since 2010, with each of the disasters from 2011 (Tohoku, Christchurch and Van), from 2012 (Mirandola) and 2013 (Bohol) being followed in terms of loss and recovery metrics.

In terms of historical statistics, this is a significant period of quiescence, with usually an average of 3 events occurring per year (for the last 113 years) using the following criteria:

Absolute: Over 1000 deaths; 200.000 homeless (non-panic); Over $8.5 billion USD (2013) losses and/or all damaging events (with structural damage) in Germany.

Relative: >30 deaths with >1 death per 100.000 pop. ; >0.8% of country population to become homeless. ; Over 3% of Gross Domestic Product (GDP) Purchasing Power Parity adjusted (PPP) with losses > $30 million USD; any extraordinary event.

This is the longest period of quiescence since 1900 with over two and a half years since the last major event (Mirandola which was Dark

Fig. 2: The Level 1 Indirect Economic Loss Potential Index globally.

Red due to economic losses via the Italian Government estimate). The largest event of the year was in 3/8/2014 event in Yunnan, China with over 729 deaths, and just short of 7 billon USD in direct losses (just short of the Dark Red rating in 2 categories).

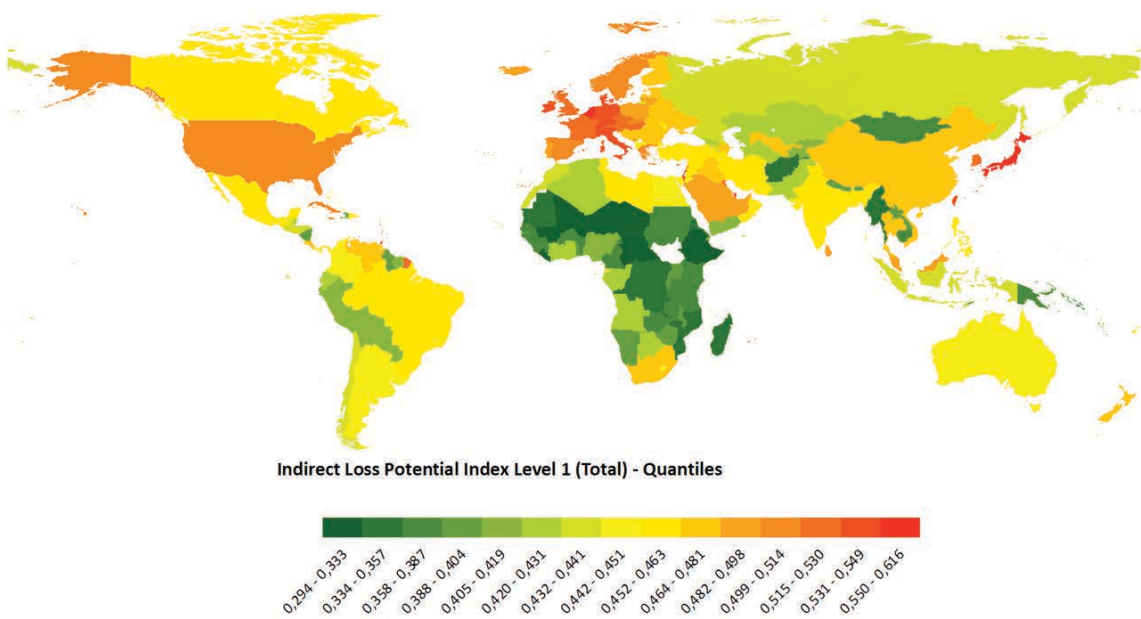During the doctoral thesis research of James Daniell, a process for rapid economic and social loss estimates has been created and tested over the past 4 years, with his thesis having being defended in February 2014. This uses parsimonious modelling using intensity, historic damage and socio-economic parameters calibrated through time to create loss functions. In addition, the review of all open source software packages for loss assessment to earthquakes (as well as other natural disasters) with the World Bank was launched at Understanding Risk 2014 (Daniell et al., 2014). In the future, indices for displacement of people post-disaster (created by Brink et al., 2015), and for indirect loss potential (Daniell et al., 2015) using combinations of capital, input-output, cross-sector, socio-economic and impact parameters will be used as part of the post-disaster effort.

The indirect loss potential index in advance of an earthquake for a similar scale event is shown in the following diagrams.

Outlook

The reports produced have previously contained many different analyses with a focus on the impacts of loss generally and have been culminated in a fast 2-page format. The reports have also been published on ReliefWeb to help aid organisations with pre-mission planning in past disasters. In addition, learning through this rapid post-disaster analysis, new research
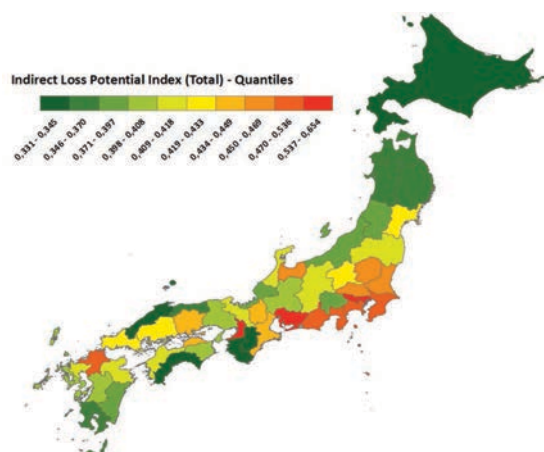
Fig. 3: The Level 2 Indirect Economic Loss Potential Index in Japan.

areas were discovered in locations where there is little or non-detailed census information, including information fill-in processes, economic modelling and other demographic, social, political and environmental modelling. The rapid post-disaster analysis methodology will be combined with indicator methods to provide post-disaster vulnerability locations in combination with loss estimates.

Core Science Team

James Daniell
Bijan Khazai
Friedemann Wenzel
Tina Kunz-Plapp
Chris Power
Susan Brink
Trevor Girard
Andreas Schaefer
 Natural Hazards and Risk Group,
 Geophysical Insitute, KIT.

Publications

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Schadensanalyse bei Erdbeben

Jedes Erdbeben der letzten 12 Monate wurde in Bezug auf die sozio-ökonomischen Folgen für die betroffenen Regionen untersucht. Über 380 Erdbeben haben Schäden verursacht, bei 200 davon waren die Schäden groß genug, dass sie in CATDAT für den jährlichen Rückblick schadenverursachender Erdbeben aufgenommen wurden. Die Zusammenarbeit mit anderen CEDIM-Projekten wurde fortgeführt. Zwar haben sich in den letzten 12 Monaten viele schwächere Erdbeben ereignet, jedoch keine mit solch schweren Folgen, dass eine Task-Force-Aktivität in CEDIM gestartet worden wäre. Die Möglichkeit der Abschätzung von Erdbebenfolgen auf Basis "sparsamer" Modelle mit wenigen Parametern wird weiter erforscht, um in Ergänzung zu sozio-ökonomischer Fragilitätsfunktionen zur Abschätzung von Toten und ökonomischen Schäden weitere Funktionen für Folgen von Erdbeben und anderen Katastrophen zu entwickeln.

ATMO Forensic Prediction and Analysis

Bernhard Mühr
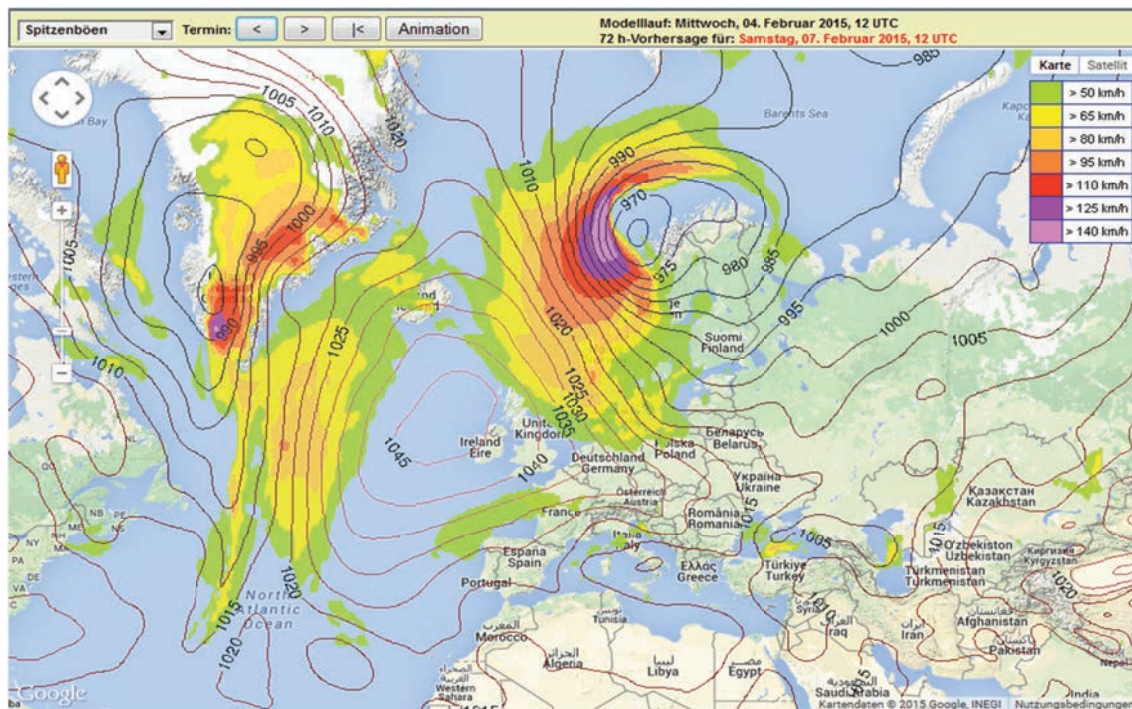
Fig. 1: Screenshot of "Wettergefahren-Frühwarnung": Forecast of wind gusts.
Image credit: http://www.wettergefahren-fruehwarnung.de.

Introduction

The combination of several indices is used to implement a forecast system for winter storms that regularly affect Germany, Central Europe or other parts of the European continent. A winter storm can be described by a storm index that is based on wind speed data from measurements. Another index or indicator, the model storm index, is calculated from model data and includes both the affected area and the storm intensity. With the use of insurance data we develop a third index; this storm damage index includes information about damage, number of fatalities or the total loss that occurred with past storm events. A forecast system is planned to become operational to describe a winter storm scenario with reasonable certainty and accuracy well in advance; a probabilistic storm damage estimation will be provided.

Short description

To calculate a storm index we use measurement data from the station network of the German Weather Service (DWD). Of particular interest is the hourly mean of wind speed and the daily maximum wind speed (gusts). According to data availability and local station characteristics the selection of stations have to be done very carefully. This work has been continued to include storm data from the previous winter storm season.

Due to the lack of station data, data gaps or changes in the station location some of the time series have to be adjusted and homogenized.

The Global Forecast System (GFS) is a global numerical weather prediction system produced by the National Centers for Environmental Prediction (NCEP). The output data are freely and routinely available. This data set is used to derive a model storm index which considers both intensity and extension of a storm field affecting Germany. The storm index is calculated for storms that lie within a forecast period of 240 hours and is also applied on past storm events. For the latter we refer to archived GFS data and the closely related CFS reanalysis data (Climate Forecast System). Each individual past storm event is labelled with an adequate

storm index. Validation is achieved through the comparison of the model storm index and the storm index, based on measurements with respect to the stratification of the atmosphere; both the average wind speed and the height of the planetary boundary will be considered.

Since the beginning of 2015 the GFS data are provided with a horizontal resolution of 0.25 degrees (around 25 km) and covers Germany with forecast data at more than 800 grid points. We need to gain wider experience during the next few months with respect to the quality of forecast peak wind gusts and 10m-mean wind speed.

GFS ensemble forecast data are also available. We will be able to provide both deterministic and probabilistic forecasts about imminent winter storms. A storm scenario may be described well in advance and with decreasing uncertainty the closer the storm gets.

Once completed (towards the end of 2015) an operational forecast system will be prescribed for Germany that predicts the probabilities of storms, their intensities and resulting loss amount classes (damage assessment). In a further step - assuming the availability of relevant damage information from past storm events - this system can be expanded across Europe or to any other regions. Moreover, with the use of high-resolution forecast models (e.g. WRF and/or ICON) further improvement of damage assessment may be expected and should be verified by case studies of upcoming storm events.

All data about past and future winter storm events will become part of a database that is currently being developed in another CEDIM project: "Development of a CEDIM Database and Implementation of Case-Based Reasoning for Analytical Support". The database entries give information about individual storm events and their characteristics such as name, date of occurrence, affected regions, intensity or damage. With the use of this database we can compare and search for storm events with similar or same attributes.

Core Science Team:

Bernhard Mühr
*Institute for Meteorology and Climate
Research, KIT*

Publications

Articles and reports of about 1000 unusual and extreme weather events worldwide since February 2004 can be found at:

www.wettergefahren-fruehwarnung.de

www.wettergefahren-fruehwarnung.de/
Ereignis/archiv.html

http://www.wettergefahren-fruehwarnung.de/
Ereignis/20131015_e.html

Forensic ATMO

„Wettergefahren-Frühwarnung" entwickelt im Rahmen von "ATMO Forensic Prediction and Analysis" ein operationelles Vorhersagesystem für Winterstürme in Deutschland, das eine Vorhersage über die Wahrscheinlichkeit von Sturmintensitäten und daraus resultierenden Schadensummenklassen erlaubt (Schadensabschätzung).

Das Vorhersagesystem beruht auf einem Abgleich von einerseits modellierten und andererseits gemessenen Windgeschwindigkeiten von Sturmereignissen der letzten Jahrzehnte.

Zusätzlich ermöglichen Schadendaten und – informationen zu diesen vergangenen Winterstürmen für bevorstehende Ereignisse die Vorhersage des wahrscheinlichsten Sturm- und Schadenszenarios (Ensemblevorhersagen). In einem weiteren Schritt kann dieses System auf Europa oder beliebige Regionen erweitert werden und durch die Verwendung hoch aufgelöster Vorhersagemodelle weiter verbessert werden. Die Kenngrößen von Winterstürmen wie Ausdehnung und Intensität des Sturmfeldes oder die Angabe der betroffenen Gebiete gehen in eine Datenbank ein, die in einem weiteren CEDIM-Projekt entwickelt wird.

Rapid Flood Event Analysis in Germany

Kai Schröter, Heidi Kreibich, Dung Viet Nguyen, Stefan Lüdtke, Bruno Merz

Introduction

Flood disaster management, recovery and reconstruction planning benefit from rapid evaluations of flood events and expected impacts. The near real time in-depth analysis of flood causes and key drivers for flood impacts requires a close monitoring and documentation of hydro-meteorological and socio-economic factors.

Aims/Objective

The aim of the rapid flood event analysis project is the development of a flood event analysis system which enables the near real-time evaluation of large scale floods in Germany. The analysis system includes functionalities to compile event related hydro-meteorological data, to evaluate the current flood situation, to assess hazard intensity and to estimate flood damage to residential buildings. Additionally, a German flood event database is under development, which contains various hydro-meteorological information in the future also impact information for all large-scale floods since 1950. This data base comprises data on historic flood events which allow the classification of ongoing floods in terms of triggering processes and pre-conditions, critical controls and drivers for flood losses.

Project status

The flood event analysis system has been implemented in a database system which automatically retrieves and stores data from more than 100 online discharge gauges on a daily basis. The current discharge observations are evaluated in a long term context in terms of flood frequency analysis. The web-based frontend visualizes the current flood situation in comparison to any past flood from the flood catalogue as shown in figure 1 for a period from August 2014 compared to the flood in August 2002. The regional flood data base for Germany contains hydro-meteorological data and aggregated severity indices for a set of 76 historic large-scale flood events in Germany. This data base has been used to evaluate the key drivers for the flood in June 2013 (Schröter et al., 2015).

The FDA activity on the flood in June 2013 in Germany also revealed useful methodological advancements of the flood event analysis system. This particularly concerns the rapid mapping of inundated areas and inundation depths
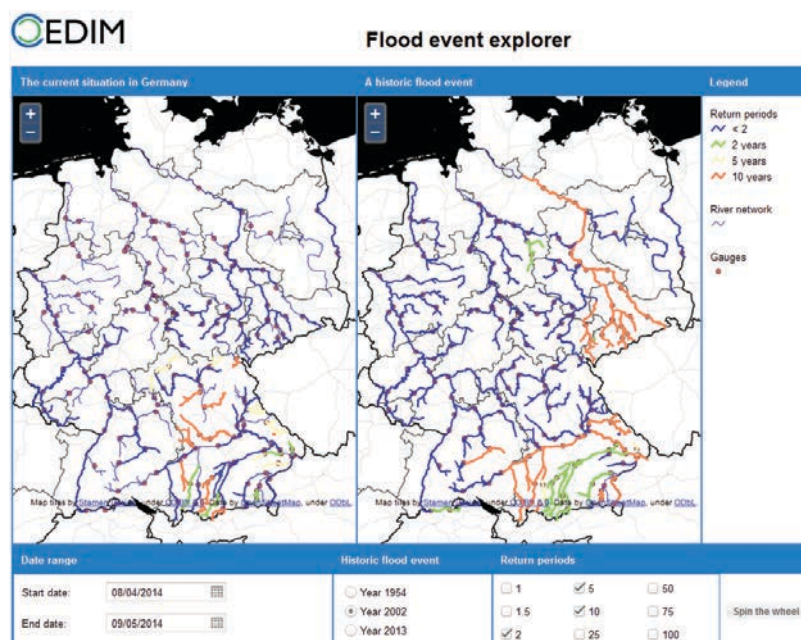

Fig. 1: Snapshot of the web-based frontend to the flood event analysis system. A flood situation in August 2014 (left) is compared to the flood in August 2002 (right) in Germany in terms of return periods.

which are essential input variables for the estimation of flood damage and the consideration of uncertain and incomplete input information within rapid flood damage estimation procedures.

For the rapid inundation mapping the suitability of social media data was tested in collaboration with the CEDIM FDA project Crowdsourcing. The Elbe flood in June 2013 in Dresden was used as a test case to investigate whether photos posted by eye-witnesses on Twitter can provide relevant and useful information for flood inundation and inundation depth mapping. The 'Tweet explorer' developed within the Crowdsourcing project automatically filters the massive amounts of data and supports the extraction of inundation depth information from photos by flood experts. Concerning the rapid estimation of flood damage the potential of probabilistic modelling approaches has been investigated (Schröter et al., 2014). Bayesian networks crystallized as being the most suitable since they provide quantitative information about predictive uncertainty and offer a consistent framework for dealing with uncertain and incomplete observations.

Outlook

Future activities are aimed at extending the data interfaces of the flood event analysis system in order to automatically retrieve data from more river gauges and additional hydro-meteorological variables. Further, the integration of multiple data sources as for instance from satellite images, water level observations, the regional flood model for Germany or volunteered geographic data within a rapid inundation mapping procedure will be investigated. Probabilistic damage models will be developed further for regional applications.

Core Science Team:

Kai Schröter
Heidi Kreibich
Dung Viet Nguyen
Bruno Merz,
 Section 5.4 Hydrology, GFZ

Publications:

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Schnelle Hochwasserereignisanalyse in Deutschland

Schnelle Analysen von Hochwasserereignissen und die Abschätzung der zu erwartenden Auswirkungen können einen wichtigen Beitrag für die Bewältigung des Hochwassers, die Wiederherstellung und den Wiederaufbau liefern. An der Sektion 5.4 Hydrologie des Deutschen GeoForschungsZentrums wird im Rahmen des CEDIM Forschungsprojekts ‚Forensische Katastrophenanalysen' ein System für die Nahe-Echtzeit-Analyse großräumiger Hochwasserereignisse in Deutschland aufgebaut. Dieses System umfasst die Zusammenführung, Analyse und Bewertung der hydrometeorologischen und hydrologischen Situation im Verlauf des Ereignisses bis hin zur Abschätzung direkter Hochwasserschäden zunächst für Wohngebäude. Dabei erfolgt auch eine vergleichende Einordnung der aktuellen Hochwassersituation mit vergangenen großräumiger Hochwasserereignisse.

Die Implementierung des Ereignisanalysesystems ruft die Tagesabflusswerte von mehr als 100 Online-Pegeln automatisiert ab und ordnet diese bezüglich der statistischen Wiederkehrintervalle ein. Darauf aufbauend werden die räumliche Ausdehnung und Stärke des Hochwassers anhand eines hydrologischen Schwereindex aggregiert und bewertet. Eine web-basierte Oberfläche visualisiert die aktuelle Hochwassersituation und stellt dieser ein ausgewähltes, vergangenes Hochwasser in Deutschland gegenüber. Dafür wird auf einen Katalog mit insgesamt 76 vergangenen großräumigen Hochwassern zugegriffen, der neben den Abflusswerten auch Informationen zum Niederschlag und zu den Vorbedingungen und zukünftig auch zu den Auswirkungen enthält.

Wesentliche Schritte zur Weiterentwicklung des Systems umfassen die Erweiterung des automatisierten Datenabrufs auf weitere Pegelstationen und hydro-meteorologische Variablen, die Entwicklung von Verfahren für die schnelle Erfassung der Überflutungsflächen und –tiefen sowie die Implementierung eines probabilistischen Schadenmodells für die Abschätzung der Hochwasserschäden bei unsicherer und unvollständiger Datenlage.

Assessment of Indirect Losses and Economic Impacts

Hanns-Maximilian Schmidt

Introduction

The cascading impact of natural disasters on economic networks is a well-known fact and widely observable. However, when it comes to its quantitative assessment the analysis lacks high-resolution data on the economic structure, especially in developing countries. Most of the available figures are highly aggregated whereas natural disasters are likely to produce direct impacts on a local area. Obviously, indirect impacts and losses in other areas cannot be evaluated and interpreted without detailed information on the affected region's economic network. Concerning this operationalization for near real-time forensic disaster analyses (FDA) the necessary data needed have to be either rapidly available or easily computed.

Aims/Objective

This project aims for a methodology for the rapid assessment of indirect economic losses due to natural catastrophes. Therefore, the main objective is to find an approach for the instant evaluation of regional economic structures and dependencies between interconnected areas. Additionally, once the local structure can be quantified, models need to be created for recalculating damages occured alongside the catastrophe that is to be analyzed. For this purpose, different simulation models are to be tested.

In order to achieve this goal, we suggest the model structure shown in figure 1 for developed countries for which national input-output data are usually available at the statistical bureaus. The combination of tools for regionalizing these economic data and models for in-depth event analyses allows for some near real-time insights into the economy's response in the case of a disturbance and into the overall economic damages.

If there are no basic economic data (national level) available – which seems to be the case in many developing countries – the regionalization needs to be done by using additional sources and approaches. The indicator-based model developed at the KIT-IIP (Merz 2011) can be used for this purpose as it is flexible and adaptable to different levels of aggregation concerning the input data. Therefore, even if there is no regionalization possible, in terms of recalculating the local input-output table, this procedure might still be a powerful tool for generating plausible scenario-based assumptions that can be used for further analyses.

Project status

The project started with an intensive literature review on different models and applications in early 2014. The mechanism suggested by Flegg & Webber (1997) combines employment statistics (on a national and regional level) and national input-output data for the purpose of calculating the regional input-output structure. Therefore, it seems to meet the requirements for analyzing regional impacts in developed countries. We implemented and tested their algorithm in MATLAB and applied it to Baden-Wurttemberg's economy. Surprisingly, even for German counties regional data on economic structures are scarce. Due to this lack of data,

the validation of the model is rather difficult. However, case studies for European counties (Flegg & Tohmo 2011; Kowalewski 2012) show that the model (and some further modifications) might still be a valid tool for analyzing sectorial interdependencies.

For developing countries the indicator-based model needs to be calibrated. We suggest that further case studies will demonstrate the potential use of that approach.

Outlook

In 2015, we will continue with the operationalization and validation of models for regionalizing official economic data provided. Additionally, we will identify compatible models for simulating damages and economic losses within the economic structure. In addition, the indicator-based model will be tested and improved in several case studies for South East Asia and official FDA events.

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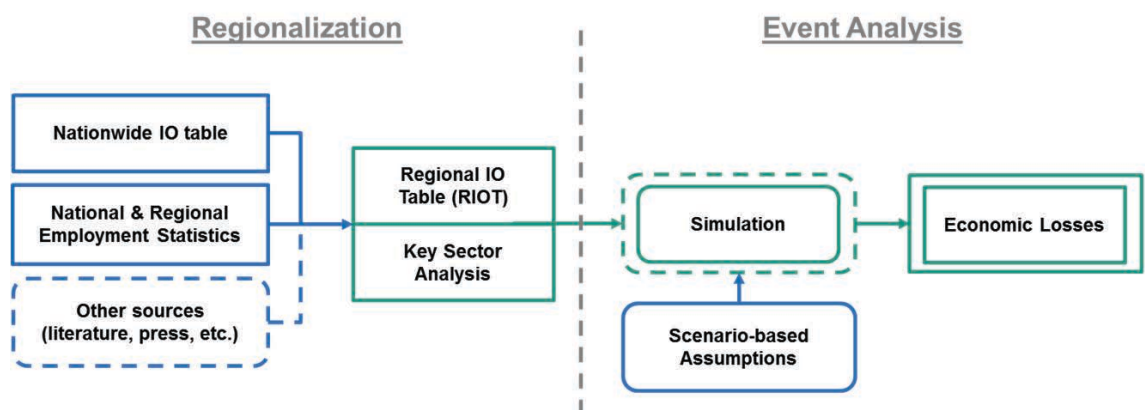

Fig. 1: Model structure.

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Core Science Team

Hanns-Maximilian Schmidt
Marcus Wiens
Frank Schultmann
Institute for Industrial Production, KIT

Methodik zur (schnellen) Abschätzung der ökonomischen Auswirkungen von Naturkatastrophen in Industrieunternehmen und über Supply Chains

Zahlreiche Katastrophen der letzten Jahrzehnte zeigten, dass lokal begrenzte Ereignisse, wie etwa Fluten oder Vulkanausbrüche, nicht nur lokale Schäden verursachen, sondern auch zu kaskadierenden ökonomischen Schäden führen können. Diese Schäden entstehen somit in Regionen, die nicht unmittelbar (physisch) beeinträchtigt sind, sich jedoch angesichts der folgenden Nachfrage- oder Angebotsschwankungen gegenüber als vulnerabel erweisen. Die Abschätzung dieser verteilten, indirekten Schäden ist dabei durch die (vor allem in Entwicklungsländern) geringe Verfügbarkeit ökonomischer Daten erschwert. Im

Rahmen des FDA-Projekts soll eine Methode entwickelt werden, mit deren Hilfe die regionale wirtschaftliche Bedeutung einer betroffenen Region bestimmt und ihre Bedeutung für indirekt betroffene Regionen quantifiziert werden kann. Der gewählte Ansatz sieht vor, dass im Falle entwickelter Länder, für die Daten der volkswirtschaftlichen Gesamtrechnung vorliegen, die Regionalisierung über die Input-Output-Tabelle erfolgt (vgl. Flegg & Webber 1997). Sollten etwaige Daten nicht verfügbar sein, wird auf ein indikatorbasiertes Modell zurückgegriffen (vgl. Merz 2011), das bei höherer Unsicherheit mehr Freiheiten in der Wahl der Eingangsparameter erlaubt. Ziel ist es zunächst, je nach Datenverfügbarkeit mit den genannten Methoden eine belastbare Grundlage für die Berechnung indirekter Schäden zu erlangen.

An Approach for Quick Road Transport Modelling to Support Rapid Impact Assessment of Transport Interruptions

Kay Mitusch, Tina Bessel

Introduction

Recent natural disasters, such as the Central European flood in June 2013 and typhoon Haiyan in November 2013, caused severe negative impacts to traffic in the affected regions. In cases where damaged infrastructure leads to long-lasting transport interruptions, natural disasters have serious impacts on the economy and the society relying on these infrastructures.

Since 2010, the Chair of Network Economics, as part of the Institute of Economics (ECON) at Karlsruhe Institute of Technology (KIT), is in-

vestigating the impacts of events that are causing a disruption of the transportation system.

Aims/Objective

In the context of CEDIM´s near real-time FDA activities, suitable assessment methods are required for a rapid analysis of transport interruptions. A transport model for the affected regions would allow a more detailed analysis of transport interruptions and their impacts on economy and society, and hence improve impact assessments. Since a transport model isn´t quickly available for every region, latest

research at the Chair of Network Economics assessed the opportunities for developing an approach for quick road transport modelling to support rapid impact assessment of transport interruptions.

Project status

The research focus is on investigating possibilities and limits of activity-based (or agent-based) transport models, which would have to be set up relatively fast after a disaster has happened. For activity-based modelling of road traffic in FDA activities, the open-source software MATSim appeared to be suitable. The software is working with an iterative algorithm to calculate fast and dynamic road transport simulations, both for private and public traffic. Results can be easily and interactively visualised. As input data, the software is using:

- network data from Open Street Map (OSM), which is widely available for many regions and easy to find during a FDA activity, and
- population data on a disaggregated level.

Since it is usually difficult to find disaggregated population data rapidly during a FDA, possible methods for using aggregated data have been reviewed. Furthermore, first test simulations with MATSim have been set up for German regions affected by the Central European flood in June 2013 and for regions in the Philippines, which have been affected by typhoon Haiyan in November 2013.

Outlook

During the initial simulations, problems with simulation assumptions and some general issues have arisen as follows:

- A main problem with the first test simulations was the lack of reliable disaggregated population data. To compensate for the lack of data and to keep the setup of a simulation quickly manageable, many assumptions had to be applied. The reliance on many and sometimes inconsistent ad hoc assumptions have led to implausible simulation results.
- For the traffic simulations, the initially chosen level of transport demand is questionable. For instance, after typhoon Haiyan had hit the Philippines in November 2013, the city of Tacloban City has been severely damaged, including the destruction of many residential buildings. It is obvious that tra-

vel demand for the inhabitants has changed significantly. However, the actual level of travel demand directly after the disaster remains unknown.
- In the case of a completely destroyed city or region, it is questionable how relevant an impact assessment of traffic disruptions in general is. In most of these cases, the losses from transport disruptions are relatively small in comparison to the overall loss caused by the disaster.

To improve the approach for quick transport modelling during FDA activities, further research on suitable methods for disaggregating available population data is needed. Since every disaster event has different impacts, it is furthermore necessary to identify disaster events where an application of quick transport modelling is reasonable.

Core Science Team

Kay Mitusch
Tina Bessel
 Institute of Economics, KIT

Transportunterbrechungen

Naturkatastrophen wie zum Beispiel die zentraleuropäische Flut im Juni 2013 oder Taifun Haiyan im November 2013 verursachten in den betroffenen Regionen deutlich negative Auswirkungen auf den Verkehr. Sobald beschädigte Verkehrsinfrastruktur zu längeren Verkehrs-unterbrechungen führt, können Naturkatastrophen einen erheblichen Einfluss auf Wirtschaft und Gesellschaft haben.

Seit 2010 untersucht der Lehrstuhl für Netzwerkökonomie am Karlsruher Institut für Technologie (KIT) die Auswirkungen von Katastrophen und Ereignissen, welche zu Unterbrechungen im Verkehrssystem führen. Im Rahmen der FDA-Aktivitäten von CEDIM werden aktuell Ansätze zur schnellen Modellierung des Straßenverkehrs untersucht, um die bisherige Methode zur Bewertung von Verkehrsunterbrechungen zu verbessern.

Der Fokus der Forschung liegt aktuell auf agentenbasierten Verkehrsmodellen, welche mit der frei verfügbaren Software MATSim erstellt und simuliert werden können. Für die mikroskopischen Verkehrssimulationen verwendet die Software Netzwerkdaten von "Open Street Map", welche für viele Regionen schnell abgerufen werden können, sowie räumlich aufgegliederte Bevölkerungsdaten. Da Bevölkerungsdaten meist nur auf einem zu hohen Aggregationsniveau vorliegen, werden zudem Möglichkeiten zur Verwendung aggregierter Daten bzw. Methoden zur räumlichen Aufgliederung aggregierter Daten analysiert.

Im vergangenen Jahr wurden für deutsche Regionen, welche von der Flut im Juni 2013 betroffen waren, sowie für Regionen auf den Philippinen, welche vom Taifun Haiyan verwüstet wurden, Testsimulationen mit MATSim erstellt und analysiert. Während dieser ersten Simulationen bereitete der Mangel an zuverlässigen Bevölkerungsdaten auf einem geeigneten Aggregationslevel Schwierigkeiten. Daher führten die Simulationen aufgrund zu vieler, zum Teil auch inkonsistenter Annahmen im Modell zu nicht plausiblen Ergebnissen. Zudem ist das zu Beginn gewählte Niveau der Verkehrsnachfrage zu hinterfragen. Es ist anzunehmen, dass die Verkehrsnachfrage bei der Bevölkerung vollständig zerstörter Gebiete erheblich vom normalen Niveau und den normalen Mustern abweicht. Da aus den betroffenen Regionen unmittelbar nach der Katastrophe jedoch keine Daten vorlagen, konnten auch hier nur Annahmen getroffen werden. Des Weiteren ist die Relevanz der Erstellung eines Verkehrsmodells und die Bewertung von Verkehrsunterbrechungen fraglich, wenn Katastrophen weiträumige Zerstörungen und große Verluste verursachen und zu vermuten ist, dass die Schäden aus dem Verkehrsbereich im Vergleich zum Gesamtschaden geringfügig ausfallen werden.

Zur Verbesserung des bisher entwickelten Ansatzes zur schnellen Verkehrsmodellierung während der FDA-Aktivitäten besteht weiterer Forschungsbedarf im Bereich geeigneter Methoden für die räumliche Aufgliederung von Bevölkerungsdaten. Da jede Katastrophe unterschiedliche Auswirkungen verursacht, ist es zudem notwendig, jene Arten von Katastrophen zu identifizieren, für welche der Einsatz eines Verkehrsmodells sinnvoll ist. Das trägt dazu bei, die Zusammensetzung von Katastrophenschäden und die tieferliegenden Ursachen von Katastrophen besser zu verstehen.

Crowdsourcing – Using Social Media for Rapid Damage Assessment

Joachim Fohringer, André Dittrich, Christian Lucas, Doris Dransch, Stefan Hinz

Introduction

Messages in social media can include a variety of observations on the impact of natural hazards. Messages from microblogs, such as Twitter, in particular, provide additional information, which is difficult or impossible to be detected by conventional sensors.

Information derived from Twitter messages 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.

Project status

Our developments are twofold: The TENAS software (Twitter Event Notification and Analysis Service) monitors geo-referenced Twitter messages based on a world-wide grid (20x20 km) in real-time and operates day and night. The software is able to robustly detect significantly high tweet volumes for any area around the world compared to a weekly updated three month moving average baseline. The subsequent analysis of the tweets' textual content identifies disaster related terms in more than 40 languages and classifies the event accordingly, e.g. as earthquake, thunderstorm, tornado, etc. Within minutes after the start of a detected event, an automatic e-mail alert is sent to the subscribers of the service.

In a next step the Observation Explorer Software allows for exploring Twitter feeds related to a specific event. It filters tweets on the basis of disaster related keywords as well as event related features such as time, geolocation, spatial entities, e.g. catchments. It also screens for photos related to tweets. The idea is to enable scientists or decision-makers to extract information from single tweets that is relevant for their tasks, in our case rapid damage estimation. We evaluated our Observation Explorer in a case study, the flood event in Dresden in 2013. Scientists derived inundation depths from photos that were combined with tweets we have filtered out from some 880.000 tweets (Fig. 1). The inundation depths thus derived
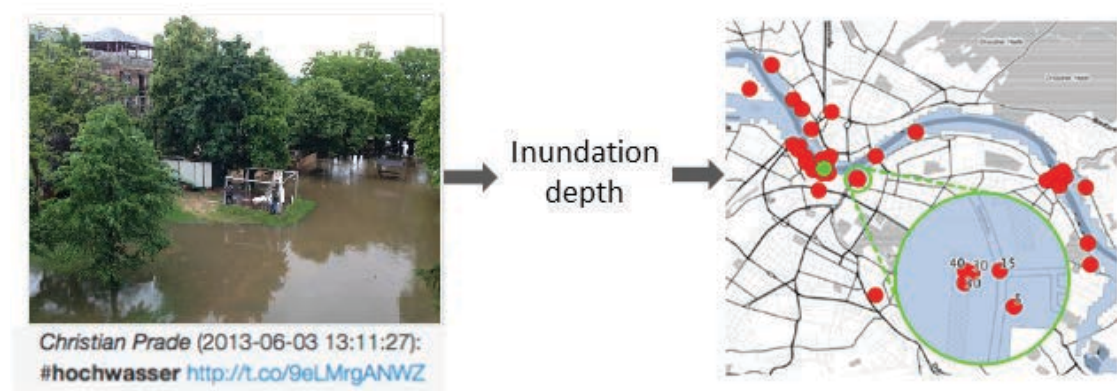

Fig. 1: Inundation depths derived from photos provided via Twitter during the flood 2013 in Dresden.

are used as model input for rapid damage estimation.

Outlook

The next steps concerning TENAS are a) the extension of language capabilities, b) the optimization of the taxonomy-based classification algorithm, and c) using TENAS as trigger for automatic distributed searches in other digital platforms such as Flickr, Instagram, or Facebook. Complementing the broad approach of TENAS, we are working on methods to automatically classify single Social Media messages into specific classes (e.g. damage report, evacuation, alarm, cry for help, etc.) and geo-reference messages without explicit geographical coordinates, based on the textual content and context knowledge. Both aspects will enable us to retrieve more detailed on-site information and hence provide better situational awareness for an event. The Observation Explorer will be customized to other natural hazards; the filtering of relevant information will be improved.

Core Science Team

Joachim Fohringer
Doris Dransch
 Section 1.5 Geoinformatics, GFZ

André Dittrich
Christian Lucas
Stefan Hinz
 *Institute of Photogrammetry and Remote
 Sensing, KIT*

Publications

Dittrich, A., & Lucas, C. (2014). Is this Twitter Event a Disaster?. In: J. Huerta, S. Schade, C. Granell (Eds.). Proceedings of the 17th AGILE International Conference on Geographic Information Science, Castellón, Spain.

Dittrich, A., Lucas, C. (2014). Social Media in crisis management and forensic disaster analysis. In: Geophysical Research Abstracts, Vol. 16, EGU2014-16626, EGU General Assembly 2014, Vienna, Austria.

Dransch, D. (2014): Big Data - Eine Herausforderung auch für die Geowissenschaften und Geoinformationsverarbeitung. - In: Geoinformationen verbinden Berlin und Brandenburg, Ministerium des Innern des Landes Brandenburg, p. 49-52.

Crowdsourcing

Ziel des Projektes ist, aus sozialen Medien Beobachtungen von Augenzeugen über die Auswirkungen von Naturkatastrophen schnell für eine Schadenabschätzung zur Verfügung zu stellen. Hierzu werden Nachrichten aus dem Microblogging-Dienst Twitter extrahiert, gespeichert und ausgewertet. Mittels statistischer Verfahren und Inhaltsanalysen werden Twitter Meldungen aus besonders gefährdeten Gebieten überwacht. Bei Erkennen eines möglichen Katastrophenereignisses wird eine Benachrichtigung über E-Mail ausgelöst. Diese informiert über die Ereignisart, Detektionssicherheit und die betroffene Region. Nachfolgend werden mit Hilfe eines entwickelten Filterverfahrens relevante Twitter-Meldungen extrahiert und für die weitere Analyse der Auswirkungen des Katastrophenereignisses bereitgestellt. Am Beispiel des Hochwassers in Zentraleuropa im Juni 2013 wurde ein Prototyp entwickelt und umgesetzt, der eine Exploration der während dieses Ereignisses gesammelten Text- und Bildmeldungen ermöglicht. Diese können von Fachexperten genutzt werden, um z.B. Wasserstände an den jeweiligen Aufnahmestandorten abzuleiten. Die gewonnenen Informationen können dazu beitragen, Daten aus herkömmlichen Sensoren zu ergänzen und Hochwasserschadenmodelle zu validieren.

Development of a CEDIM Database and Implementation of Case-Based Reasoning for Analytical Support

Stella Möhrle, Wolfgang Raskob

Introduction

The project CEDIM Forensic Disaster Analysis (FDA) is concerned with near real-time analyses of disasters and their impacts. The implementation of case-based reasoning (CBR) should provide an IT-based support for near real-time assessments of current disaster events. CBR makes use of similarities between events and offers the possibility to quickly draw first conclusions about a current event, in particular when little information is available. Since the approach is not limited to a certain type of disaster, the project aims at developing a structured storage facility for historic earthquake, flood, and storm events and applying CBR for analytical support.

Aims/Objective

Within the FDA, inferring from similar past events should support the understanding of a new and to a large extent unknown disaster. Conclusions relate primarily to the categorization of the current event and the assessment of possible damages. The contribution comprises the establishment of a common database and the implementation of CBR within the framework of FDA. Attributes need to be defined in collaboration with experts capturing general and event specific characteristics. Furthermore, intelligent and flexible similarity functions need to be specified and developed to limit the space of possibly interesting events.

Project status

The focus of this year was on implementing CBR and defining similarity functions, respectively. So far, functions depend on the attribute type. The application is flexible and enables an ad-hoc configuration. This applies to the choice of attributes for the retrieval step and whether exact matches are requested or not. Furthermore, importance values of attributes are set individually. The development of a web interface is ongoing where experts can set up their query and configure the similarity function. Furthermore, they can select which information is needed from historic events for further analyses.

Outlook

The application and web interface will be programmed further, including research activities on similarity functions. Among other work, the generic functions need to be adapted to the attributes. Research will be accompanied by an exchange with experts and the application will be expanded and improved iteratively.

Core Science Team

Stella Möhrle
Elvira Munz
Thomas Münzberg
Wolfgang Raskob
Tim Müller
Lijun Lin
Evgenia Deines
Stefan Wandler
Andreas Motzke
 Insitute for Nuclear and Energy Technologies (IKET), KIT

Publications

Möhrle S. and Raskob, W. (2014): Case-based analytical support for rapidly assessing natural disasters, 14. Forum Katastrophenvorsorge, Leipzig, Germany.

Entwicklung einer CEDIM Datenbank und Einsatz des Fallbasierten Schließens zur Analyseunterstützung – Fortführung von 2013

Im Projekt CEDIM Forensic Disaster Analysis (FDA) werden Katastrophen und deren Auswirkungen zeitnah analysiert. Die Implementierung des Fallbasierten Schließens soll hierbei eine IT-Unterstützung zur zeitnahen Kategorisierung und Schadensabschätzung gegenwärtiger Katastrophen zur Verfügung stellen. Insbesondere sollen mithilfe ähnlicher, vergangener Ereignisse Rückschlüsse auf ein neues noch weitgehend unbekanntes Ereignis gezogen werden. Der Ansatz ist nicht auf bestimmte Katastrophentypen beschränkt und soll auf Erdbeben, Hochwasser und Stürme angewandt werden. Dieser umfasst unter anderem die strukturierte Ablage historischer Ereignisse. In Zusammenarbeit mit Experten wurden allgemeine und ereignisspezifische Merkmale zur Ereignisbeschreibung definiert. Des Weiteren werden intelligente und flexible Ähnlichkeitsfunktionen entwickelt, um die Menge der möglicherweise interessanten Ereignisse aus der Vergangenheit einzugrenzen. Die Anwendung ist flexibel und erlaubt ad-hoc Konfigurationen sowie das Gewichten verschiedener Attribute. Die Anfragen werden über eine Webschnittstelle realisiert. Während die Forschung durch einen ständigen Austausch mit Experten begleitet wird, wird die Anwendung weiter ausgearbeitet und verbessert.

Information Gap Analysis: Near Real-Time Evaluation of Disaster Response

Trevor Girard

Introduction

During a disaster situation the public will need to make critical decisions/actions regarding what to do, where to go, how to get there, and so on. A key hypothesis is that the more informed the public is, the better decisions/actions they are able to make, resulting in reduced disaster impacts. This research project investigates the dynamic information needs of disaster affected populations and analyzes how well informed the public is during disasters.

Aims/Objective

The purpose of the research project is to identify key indicators for measuring how well informed the public is during disasters. The indicators are limited to those which can be observed as communication is happening. By doing so, the indicators can be analyzed as disaster situations unfold, deficiencies can be identified, and recommendations can be made to potentially improve communication while the response is still underway. The end goal of the research is to improve the ability of communicators to inform disaster affected communities.

Project status

A classification scheme has been developed to categorize the information provided to the public during disasters. Under each category is a set of typical questions that the information should answer (result of best observed practice review), as shown on the right of figure.1. For example, under the category 'Life Saving Response', the questions which should be answered are who is doing what (Evacuation, SAR), when and where, and the amount of the affected communities' needs being covered by these actions (coverage). Review of what questions remain unanswered acts as the first indicator identified in figure 1, referred to as an 'Information Gap Analysis'. The remaining indicators identified in figure 1 are also potential candidates for being observed in near real-time.
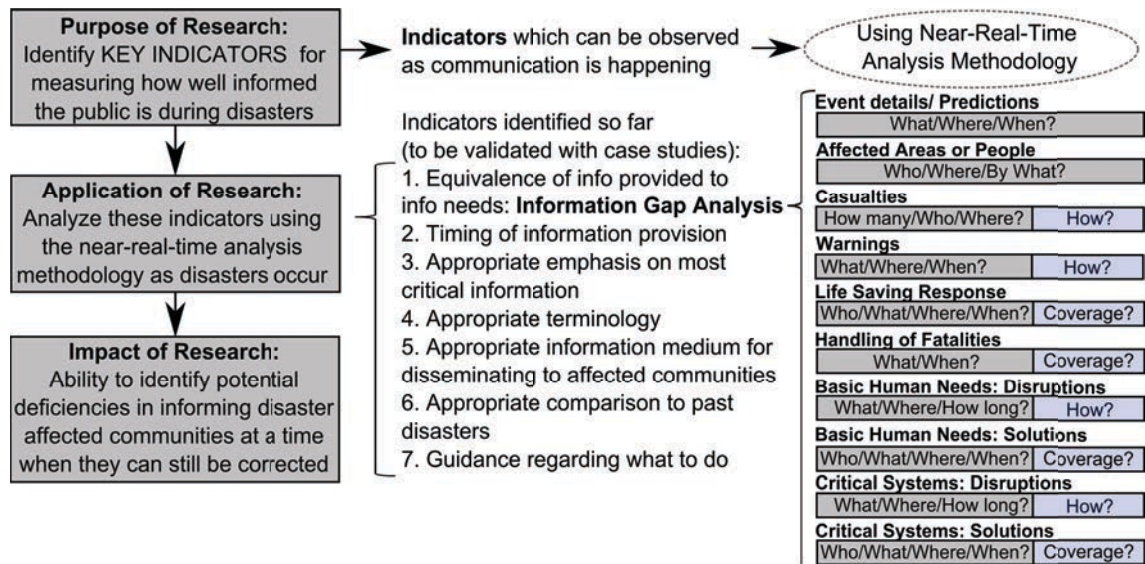
Fig. 1: Overview of Research.

Outlook

A case study is planned to be carried out in the Philippines in 2015 in areas affected by typhoons Haiyan and Hagupit. A major purpose of the case study is to confirm, through interviews with disaster affected communities, what their information needs were during the typhoons, what information they actually received and how they received that information. Comparisons can then be made with what information the disaster management system produced and how they disseminated that information. The case study will help to confirm the validity of the indicators identified so far and potentially identify others.

Core Science Team

Trevor Girard
 Geophysical Institute, KIT

Publications

Girard, T., Wenzel, F., Khazai, B., Kunz-Plapp, T., Daniell, J.E., Brink, S.A. "Near-Real-Time Analysis of Publicly Communicated Disaster Response Information", International Journal of Disaster Risk Science. Vol 5:3, pp 165-175. November 2014.

Information Gap Analysis

Ziel dieses Forschungsprojektes ist es, Indikatoren herauszustellen, die bemessen, ob die Öffentlichkeit während einer Katastrophe ausreichend informiert wird. Die Indikatoren beschränken sich auf solche, die während der Kommunikation messbar sind. Dementsprechend können sie noch analysiert werden, während die Katastrophe im Gange ist. Somit können Defizite ermittelt und Empfehlungen ausgesprochen werden, um möglicherweise die Kommunikation noch während der Bewältigungsphase zu verbessern. Das Endziel der Forschungsarbeiten besteht darin, die Kompetenzen derer zu verbessern, die betroffene Gemeinden während einer Katastrophe informieren müssen.

Causal Loss Analysis

Susan A. Brink, James Daniell, Friedemann Wenzel, Bijan Khazai, Tina Kunz-Plapp

Introduction

The relationship between a hazard and its impacts on the infrastructure, environment and population is complex and varies across events. In particular the medium and long term social impacts of a disaster can be very difficult to estimate even after an earthquake or wind storm has passed and the physical damage is known. Vulnerable population, response efforts and many other factors influence the severity of the social impacts leading to difficulties for estimation and preparedness efforts.

Aims/Objective

The Causal Loss Analysis project studies population displacement after a disaster event to understand the root causes that lead to large numbers of displaced persons, lengthy displacements and high shelter demand. This project analyzes historical events to understand the factors that are associated with severe population displacement.

The first objective of the project is to determine to what extent data on historic events could be used to determine the relationship between the impact of the event and the number of displaced persons. Using methodology developed by Daniell (2014), the CATDAT database of historical earthquakes is analyzed to develop a standard relationship between hazard intensity and population displacement. This research has led to the development of a social fragility function that can provide an initial estimate of the number of displaced people after an earthquake.

Although there is a clear relationship between the physical intensity of an earthquake or other hazard and the population displacement caused by the event, there are many other factors that can aggravate or reduce the severity of the population displacement in an event. The second objective of the Causal Loss Analysis Project is to determine the root causes that can increase the probability, severity or length of disaster population displacement.

The Causal Loss Analysis project includes a thorough review of the literature addressing population displacement in historic events to generate an understanding of both the types of disaster population displacement and the factors that have been associated with it in past events. This has led to the development of an initial framework to represent the severity of population displacement and an index to measure vulnerability to displacement in disaster events.

Finally, in depth analysis of individual case studies of historic disaster events complements the historic earthquake data analysis and literature review. The analysis aims to identify additional factors that are root causes of population displacement as well as to analyze and quantify the indicators, their interactions and their impact on population displacement.

Project status

Ongoing.

Outlook

It is hoped that the Causal Loss Analysis project will identify some of the key indicators required for FDA analysis in the near-real time of a disaster. By including these root causes of population displacement in the analysis, the FDA process will be able to more comprehensively estimate post-disaster shelter demand.

Core Science Team

Susan A. Brink
James Daniell
Friedemann Wenzel
Bijan Khazai
Tina Kunz-Plapp
 Geophysical Institute, KIT

Publications

Daniell, J. (2014). "The development of socio-economic fragility functions for use in worldwide rapid earthquake loss estimation procedures." PhD Thesis. Karlsruhe Institute of Technology.

Brink, S., Wenzel, F., Daniell, J. and Khazai, B. (2014). "Causal Loss Analysis: A new approach

to understand risk driving factors." Proc., 2nd IRDR Conference. Beijing, China.

Brink, S., Daniell, J., Khazai, B. and Wenzel, F. (2014). "Development of fragility functions to estimate homelessness after an earthquake." Proc., European Geosciences Union General Assembly 2014, Vienna, Austria.

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Khazai, B.; Daniell, J. E.; Kunz-Plapp, T.; Wenzel, F.; Vervaeck, A.; Mühr, B. (2011): Shelter report for the Oct. 23 2011 Eastern Turkey Earthquake. CEDIM Forensic Earthquake Analysis Group. Available online at http://www.cedim.de/download/CEDIMForensicEQAGTurkeyVanEQ_Report3.pdf.

Causal Loss Analysis

Das Causal Loss Analysis-Projekt befasst sich mit historischen Naturkatastrophen um Faktoren zu identifizieren, die die Schwere des Desasters beeinflussen. Hierbei liegt der Fokus vor allem auf der Untersuchung der Verdrängung der Bevölkerung sowie den Bedürfnissen der Opfer. Das Projekt beinhaltet einen Überblick zu Literatur, die sich mit Katastrophen befasst, um Faktoren zu erkennen, welche in der Vergangenheit mit der Dislokation der Bevölkerung assoziiert wurden. Zusätzlich wurden im Rahmen des Projektes quantitative Analysen historischer Ereignisse durchgeführt, um zusätzliche Faktoren zu ermitteln, welche die Verdrängung der Bevölkerung beeinflussen sowie um festzustellen, in welchem Umfang die Bevölkerungsdislokation nach einer Katastrophe vorhergesagt werden kann.

User-oriented Visualization for CEDIM FDA Reports

Silke Eggert

Introduction

In times of a natural disaster fast and up-to-date information is crucial to quickly understand the catastrophe and its possible impact. One aim is to identify the root causes of the event to derive implications for a long-term risk reduction. Comparison of recent events with historic disasters can help understanding why one event was disastrous while another caused almost no damage. CEDIM introduces the concept of Forensic Disaster Analysis (FDA) while incorporating a real-time component to impact assessment.

The FDA report readership mainly consists of four groups: civil protection/disaster management, media, scientists and general public. The readers' demand on rapidity and type of information as well as their level of knowledge is very heterogeneous. Especially for the first two groups information in near real-time is essential while others focus on in-depth analysis. To better serve the users' needs and improve communication in times of a disaster, CEDIM started the project "User Oriented Visualization".
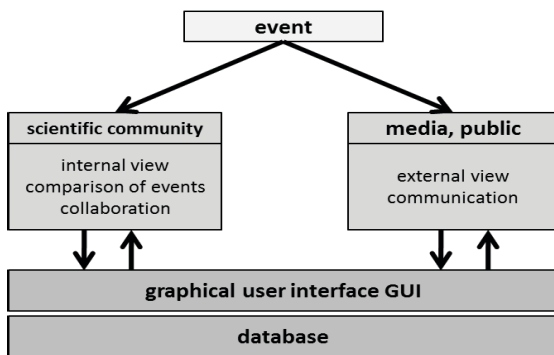
Fig. 1: Schematic structure of the Event Explorer.

Aims

Evaluate our readers' needs concerning information after natural disasters.

Adapt the data visualization as well as the report layout and format according to the reader's needs.

Project status

In the first phase, we followed two approaches. (a) Learn more about the FDA reports readers and gain insight into their needs and wishes. (b) Test and evaluate new methods and approaches of data visualization and presentation.

Motivation

To improve the two aspects mentioned above (a) reader oriented presentation of results and (b) comparison of events, we want to develop a new platform. It should (a) let the reader search the database interactively for historical events and (b) present FDA results more concisely and better focused on the reader's state of knowledge. The working title is "Event Explorer".

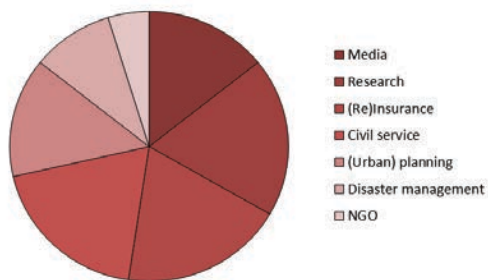Figure 1 shows a schematic structure of the Event Explorer. A database with information

Fig. 2: Results of the FDA report readers survey 1: CEDIM FDA report readers according to their field of profession.

on recent and historic events, starting from a simple base map to detailed analysis will be the basis for the Event Explorer. The results of all FDA projects will be included as well as external data, users can access and search the database via a graphical interface [see Fig. 1].

Implementation

The Event Explorer will mainly focus on three user groups: media, disaster management and (re)insurance/research. These groups reflect the participants in the FDA survey [see Fig. 2].

The central point is to improve the presentation of FDA analyses to make it more suitable for individual users. The FDA reports so far are a classic mixture of text and figures published and updated whenever a considerable collection of information is available. The format is PDF but many readers tend to move away from the desktop workstation and are more interested in real-time updates for mobile devices. Key facts should therefore be identified easily and maps should be more interactive to fit the individual needs. Figure 3 shows the main user needs expectations of the FDA reports. That is why FDA results will be edited according to the users' needs and users' state of knowledge as, for example, journalists are interested in a different type of analysis than people working for insurance.

From the scientific point of view, the Event Explorer will act as an internal database for interdisciplinary results. To improve the analysis for future events, the Event Explorer enables searches for similar events and compare results with historic events.

The first prototype is designed as a blog. From the FDA point of view it is very convenient to handle: new results can be added as soon as they are available to keep the event page up-to-date. The format covers not only text and static figures but also allows interactive maps, picture galleries and videos. The reader will be provided with up-to-date information and can follow the blog via RSS-feed to stay informed. Keywords and tags let the user search for related events, results or methods. The format is independent from any device and adaptable for desktop PC, smartphone or any other device.

Outlook

For the future, the underlying database will be defined more precisely such as 'What type of information is needed for what type of disaster?', 'What results are mandatory to obtain a complete view?' and 'What extra information is available?'. Results obtained from the user survey will also be incorporated into the prototype because according to their profession, users gave different ideas and input for the design. The prototype will also be tested in different environments and with different users.

Finally, a user-oriented visualization of FDA results will increase the spread of disaster analyses and will make it a valuable contribution to the further use of CEDIM results.
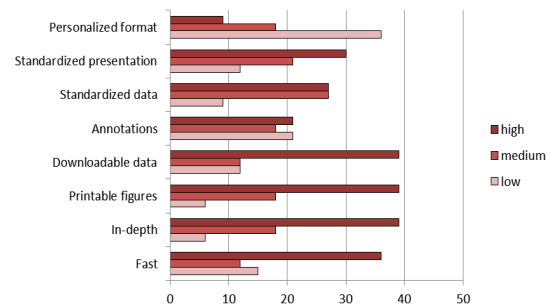

Fig. 3: Results of the FDA report readers survey 2: readers' priority (low/medium/high) of different aspects of the FDA report.

Core Science Team

Silke Eggert
GFZ Potsdam, Section 2.1

Danijel Schorlemmer
GFZ Potsdam, Section 2.6 (former 2.1)

Anwenderorientierte Visualisierung für CEDIM-FDA-Berichte

In Zeiten von Naturkatastrophen ist es sehr wichtig, schnell aktuelle und vergleichende Informationen bereit zu stellen, um die Katastrophe und ihre möglichen Auswirkungen sofort zu verstehen. Die CEDIM-Leserschaft besteht hauptsächlich aus vier Gruppen: Zivilschutz/Katastrophenmanagement, Medien, Wissenschaftler und die Öffentlichkeit. Um die Bedürfnisse der unterschiedlichen Nutzergruppen besser zu bedienen und die Kommunikation im Ernstfall zu verbessern, sollen diese evaluiert werden und die Datenvisualisierung sowie Layout und Format der Berichte daran angepasst werden.

Im Vordergrund steht die Entwicklung einer Plattform (Arbeitstitel „Event Explorer"), um die beiden Aspekte „Leser orientierte Präsentation der Ergebnisse" und „Ereignisvergleiche" zu verbessern: Die Ergebnisse aller FDA-Projekte sollen hier ebenso enthalten sein wie externe Daten. Die aktuellen Nutzer interessieren sich zunehmend für Echtzeit-Updates in mobilen Geräten. Die wichtigsten Fakten sollen leichter identifiziert werden können und Karten interaktiver zu den individuellen Bedürfnissen passen. Der Event Explorer soll weiterhin als interne Datenbank für interdisziplinäre Ergebnisse funktionieren, um das analytische Arbeiten zu verbessern.

Der erste Prototyp ist als bequem zu handhabender Blog konzipiert. Das Format umfasst sowohl Text, statische Zahlen als auch interaktive Karten, Bildergalerien und Videos. Keywords und Tags lassen den Benutzer verwandte Ereignisse, Ergebnisse oder Verfahren finden. Das Format ist unabhängig und an die üblichen großen Bildschirme anpassbar aber eben besonders für Smartphones, Tablets und andere mobile Geräte konzipiert. Für die nahe Zukunft müssen wir uns genauer fragen, welche Informationen für welche Art von Katastrophe und für welchen Nutzer benötigt werden? Der Prototyp muss in unterschiedlichen Umgebungen für die mutmaßlichen Benutzertypen getestet werden.

Global Dynamic Exposure

Thomas Beutin, Danijel Schorlemmer, Jochen Zschau

Introduction

In the Global Dynamic Exposure (GDE) project we use crowd-sourced and open geographic/geospatial data from the OpenStreetMap (http://www.openstreetmap.org/) project and additional available open data. Using these data, which are extended and updated permanently by a continually growing number of volunteers on the one hand and local or even countrywide governmental organizations on the other hand, we are deriving a permanently updated global exposure model.

We also provide guidance supporting the "crowd" by not only geographic data collection, but also by deriving information required to improve our exposure and vulnerability indicators. Because of the immense number and variety of buildings and their locations, exposure- and vulnerability-related data cannot be compiled by a small or local group.

Furthermore, the dynamic aspect of risk, namely rapid urbanization in emerging countries, requires monitoring of exposure and vul-

Fig. 1: Mobile OpenStreetMap building property data editor.

nerability indicators, again a task that can only be achieved when distributing the work onto many shoulders.

Aims/Objective

The objective of the Global Dynamic Exposure project is to provide a high-resolution (on the building-by-building level) and dynamic (low-latency) exposure model for the world. It will build upon the Global Exposure Database for the Global Earthquake Model (GED4GEM) and augment it where crowd-sourced and open data exists in high quality.

The exposure and vulnerability indicators are derived from geographic data (e. g. building footprint, land use), building properties (e. g. type of building, occupancy), and semantic interpretation (e. g. regional types of architecture, cultural habits). As can be seen in figure 3, these indicators can be computed for many buildings if sufficient data exists in OpenStreetMap. Once a target area is fully captured in OpenStreetMap, further changes in the dataset indicate the change in building stock or the process of urbanization.

To keep up with the dynamic of crowd-sourced data collection, our system updates our OpenStreetMap replica database minutely. After every update, indicators for buildings affected by recent updates are newly computed to provide low-latency dynamic exposure data.

This dynamic aspect of data collection is of interest in our parallel project, the Post-Disaster Damage Mapping. Here, the so-called Humanitarian OpenStreetMap Team (http://hot.openstreetmap.org/), a quick responding crowd-sourced post-disaster mapping effort, is providing information about the status of buildings and roads in the aftermath of a disaster. These data are retrieved mainly from open (at least for this particular purpose) aerial imagery but also from mappers on the ground.

Combining the exposure and vulnerability data of buildings prior to a natural disaster with the post-disaster damage status will provide a new dataset for better understanding risk but also the societal impact of a catastrophe.
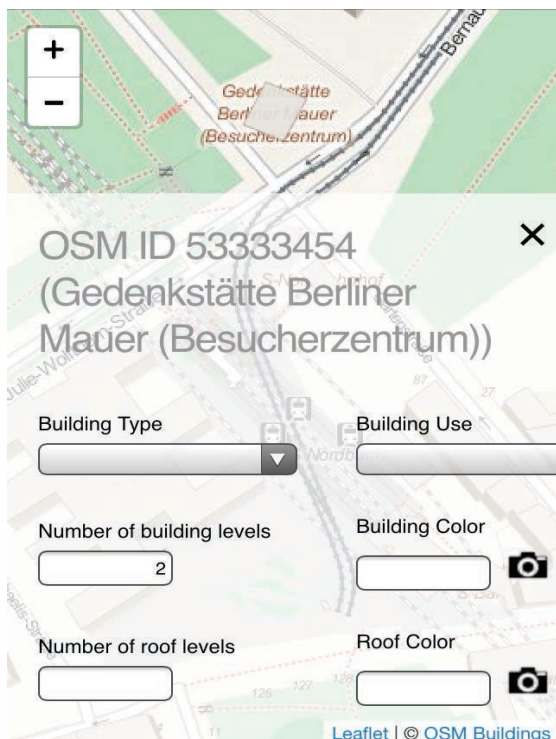
To spread the idea of volunteering as a scientist, engineer or "ordinary mapper" we provide the infrastructure for near real-time updated visualization of multi layer exposure maps on a global scale.

Project status

After finishing the proof-of-concept phase we became aware of the immense amount of information contained in our basic dataset in some parts (i.e. regions) and the lack of data in others (see Fig. 2). Therefore we decided to search for planned or initiated projects for building mass imports into the OpenStreetMap database, and offered our guidance for selecting available information and choosing appropriate tags (see below in support of planned and ongoing mass building imports).

Since our global OpenStreetMap database is up, running reliably and being updated minutely, we are now working on the infrastructure for real-time re-calculation of exposure data. Also, we have introduced algorithms for new exposure and vulnerability indicators and implemented them in the cotinuously running distributed computation system.

OpenBuildingMap

We extended the OpenBuildingMap (http://www.openbuildingmap.org/) by numerous layers of newly derived or calculated indicators (i.e. ground area, floor space, power infrastructure). We try to address two main goals in this project:

- create a visualisation of the calculated indicators
- stimulating mappers worldwide to capture building properties that are usually not visible in the generic maps (see Building Property Editor for Mobile Devices below)

Also we worked with the community to improve the quality and speed of the tools used to import and extract OpenStreetMap data. We put effort in creating a tool chain to visualize the progress of the completeness of OpenStreetMap data for certain regions.

Support of planned and ongoing mass building imports

Together with local mappers, we work on the import of building outlines and building occupancy information in different locations on the world (Cologne, Germany; Palermo, Italy; Helsinki, Finland; Lecce, Italy; Portland, OR, U.S.A.).

For these mass imports we created translation tables for all of the imported occupancy types. Those tables provided the respective tags in OpenStreetMap for the data import but also the respective taxonomy tags for exposure assessment. These imports are mostly performed manually as otherwise they would need considerable advance preparation for data quality reasons.
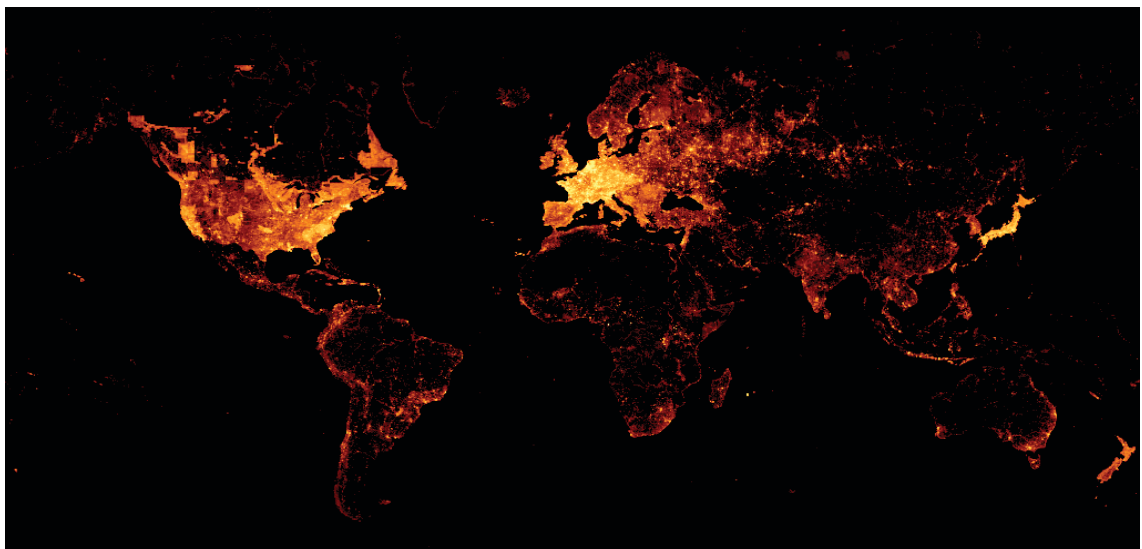

Fig. 2: OpenStreetMap worldwide node density distribution as of June 2013.
Visualization based on work of Martin Raifer ("tyr_asd"), © cc-by-sa - source data © OpenStreetMap contributors, ODbL.
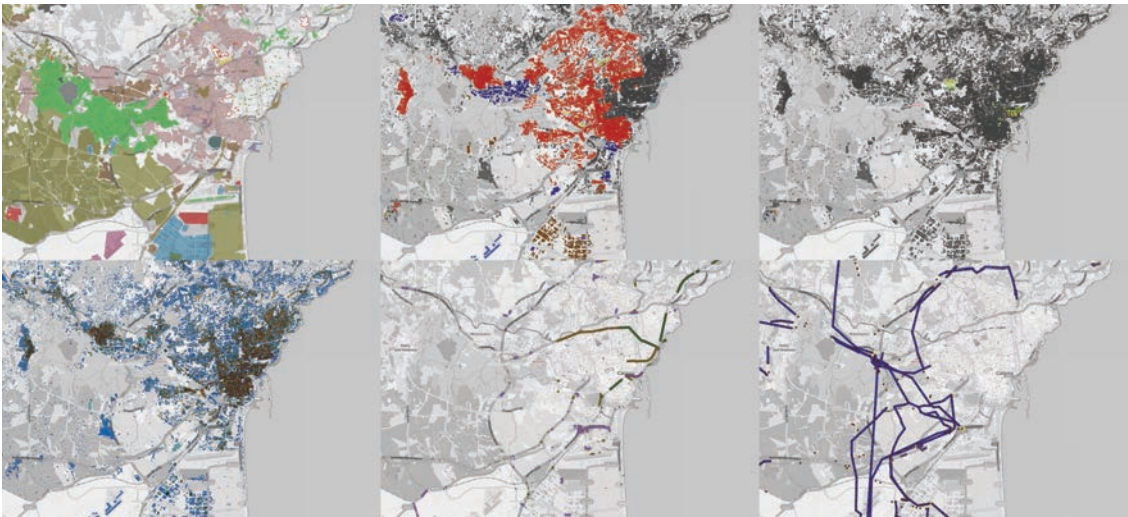
Fig. 3: Color-coded exposure indicators derived from OpenStreetMap data of Catania (east cost of Sicily, Italy). From top left to bottom right: Predominant landuse, occupancy type of building, number of storey of building, number of ? buildings, bridges and tunnels, and finally, electrical power related information. Source data © OpenStreetMap contributors, OdbL.

OpenExposureMap

Our former proof-of-concept static map is now included in the near real-time updated Open-BuildingMap.

Damage maps

Derived from our Haiyan/Yolanda typhoon proof-of-concept damage map we created the infrastructure to deploy similar maps for future events in short time.

Building Property Editor for Mobile Devices

In collaboration with other community participants we developed a proof-of-concept mobile building property editor (see Fig. 1) for any HTML5 capable device. The goal is to have a simple to use tool for adding building property data into the OpenStreetMap project and to direct volunteers to focus onto easily recognizable data that helps the Global Dynamic Exposure project.

Outlook

By adding additional hardware to the GDE database system we extend the number of exposure indicators computed by the system on the global scale.

The increasing amount of open data in the public, esp. in the OpenStreetMap database, requires us to put more effort into the optimization of the distributed calculation system to be kept updated with the changes in our source dataset(s).

We develop the possibilities to face the challenge of motivating numerous locally dependent experts ("crowd" of earthquake engineers and scientists) to interpret the datasets and add algorithms for processing the data of their regions of knowledge. We consider this our major task for improving the quality of the Global Exposure Model.

We will improve the capabilities of the damage map system to show layers from various sources which may contain almost arbitrary geospatial data.

To attract volunteering developers we will clean our so far proof-of-concept code of this project and made it available on a public open source collaboration platform.

We will create a platform where the results of our calculation are available for browsing and download either as dynamic up-to-date set or a periodically dumped release.

Core Science Team

Thomas Beutin
Danijel Schorlemmer
 GFZ Potsdam, Section 2.6 (former 2.1)

Jochen Zschau
 GFZ Potsdam, Section 2.1

Global Dynamic Exposure

Das Ziel des Global Dynamic Exposure Projekt ist die Ermittlung von Vulnerabilitäts- und Exposureindikatoren aus Daten hauptsächlich vom OpenStreetMap Projekt (http://www.openstreetmap.org/), die auf der Basis von Croudsourcing gewonnen werden und dessen Bestand sich in den letzten Jahren rasant entwickelt hat. Die in diesen Daten enthaltenen Informationen gehen dabei über die zur Erstellung von Karten nötigen Eigenschaften weit hinaus: die Indikatoren werden anhand der geographischen Daten, der Gebäudeeigenschaften und Ihrer semantischen Interpretation ermittelt und bei Änderungen im Ausgangsdatenmaterial annähernd in Echtzeit neu berechnet. Diese Dynamik trägt der immer schneller fortschreitenden Urbanisierung – besonders in Schwellenländern – Rechnung. Im Fall großer Katastrophen lassen sich unter Zuhilfenahme von aktuellen Luftbildern zeitnah neue Details über das Ausmaß der Zerstörung betroffener Gebiete ermitteln.

FDA Task Force Activities

Iquique (Chile) Earthquake, 1. April 2014

Silke Eggert, Andreas Höchner, James Daniell, André Dittrich, Ronjang Wang, Yong Zhang, Joachim Fohringer

Introduction

The M_W 8.2 Iquique earthquake (also called Pisagua earthquake) struck Northern Chile on 1st April 2014 northwest of Iquique. It was the strongest earthquake in this area for the last 137 years. With a hypocentral depth of 34 km and located about 96 km offshore of the harbor city of Iquique it belongs to the type of subduction-thrust earthquakes along the Chilean coast.

The Northern Chile seismic gap

The event occurred in a region of historic seismic quiescence, the Northern Chile seismic gap. The earthquake ruptured a part of the gap close to its northern end, where the Nazca plate subducts eastward beneath the South American plate at a rate of ~65 mm/yr. The last significant earthquakes occurred in 1868 and 1877. Since then the region has been quiet and built up stress along the segment for the last 140 years. The two neighboring segments to the north and south of the seismic gap broke in 2001 and 1995, causing magnitude 8.4 and 8.1 earthquakes respectively (Fig. 1). A recent increase in seismicity had occurred just before the M_W 8.2 event, including an M_W 6.7 event and three M_W 6.2 events in March. The remaining unbroken parts of the seismic gap now pose an increased seismic hazard with the potential to host an earthquake of magnitude larger than 8.5.

Historic seismicity

Since population is sparse due to the Atacama Desert, most earthquakes in Northern Chile cause minor human losses. Economic losses, mainly for the mining industry are higher. Past damaging events:

Date	Magnitude	Casualties	Damage	Economic Loss
1987	7.2	5 dead 5000 homeless	1000 houses damaged	ca. $1M USD
1911	7.1	20 dead	Damage to nitrate industry	major
1877	8.8	ca. 2500 dead	Major damage, tsunamis	major (also war)

Table 1: Major historic earthquakes along the Chilean subduction zone.

2005 saw a major Mw7.8 earthquake killing 11 people and causing landslides in the region of Iquique, however this was an intermediate depth earthquake at 100km depth, 1981 also saw a minor Mw5.8 earthquake with 10 deaths. (CATDAT)

Human and economic losses

At least 15 people died due to the shaking and later building collapse. Around 1000 persons became homeless while 90,000 in total were affected by evacuation. Damage to buildings and infrastructure was mostly minor but reached up to southern Peru. Major damage was observed mainly in Huara and Altophospicio, cities near to Iquique. The event generated a small tsunami of 1-2 m height which did not cause any major damage, a fact also due to the sparsely populated nature of the Chilean coast in that area. Few roads were closed by landslides. The mining industry reported modest economic losses in the order of $10m.

Because of the relatively little damage and losses incurred, the Iquique earthquake did not match the criteria set for a CEDIM Forensic

Fig. 1: Map view earthquakes in Chile and the seismic gap (Graphic: Klinghammer, GFZ).

Disaster Analysis but since the event is of major scientific interest, a short report was published and a study with contributions from CEDIM members was published in Nature [Schurr et. al.].

Core Science Team

Silke Eggert
Andreas Höchner
Ronjang Wang
Yong Zhang
 GFZ Potsdam, Section 2.1 Physics of Earthquakes and Volcanoes

James Daniell
 Geophysical Institute, KIT

André Dittrich
 Institute of Photogrammetry and Remote Sensing, KIT

Joachim Fohringer
 Section 1.5 Geoinformatics, GFZ

Publications

Schurr B., Asch G., Hainzl S., Bedford J., Hoechner A., Palo M., Wang R., Moreno M., Bartsch M., Zhang Y., Oncken O., Tilmann F., Dahm T., Victor P., Barrientos S., Vilotte J.-P. (2014): Gradual unlocking of plate boundary controlled initiation of the 2014 Iquique earthquake, Nature, doi:10.1038/nature13681.

http://www.cedim.de/download/Short-report_IQUIQUE_2.pdf

http://www.eskp.de/wissenschaftler-untersuchen-vor-und-nachbeben-in-chile/

Erdbeben "Iquique", Chile

Das M_W=8.2 Iquique Erdbeben (auch Pisagua-Erdbeben genannt) ereignete sich am 1. April 2014 nordwestlich von Iquique. Es ist das stärkste Beben in dieser Region der letzten 137 Jahre. Das Beben gehört zu den Subduktionsbeben entlang der Küste Chiles, wo die Nazca-Platte mit einer Geschwindigkeit von ungefär 65 mm pro Jahr nach Osten unter die südamerikanische Platte abtaucht. Die letzten großen Beben ereigneten sich 1868 und 1877, seither bauten sich kontinuierlich tektonische Spannungen auf. Die sich im Norden und im Süden anschließenden Segmente brachen 1995 und 2001 und verursachten Beben der Stärke 8.4 und 8.1 (Bild 1).

Bei dem Iquique-Beben am 1. April 2014 kamen 15 Personen kamen aufgrund der Erschütterung und Gebäudeeinstürzen ums Leben. Ungefähr 1.000 Personen wurden obdachlos und etwa 90.000 waren von der Evakuierung betroffen. Die Schäden an Gebäuden und Infrastruktur waren größtenteils gemäßigt. Das Ereignis verursachte einen kleineren Tsunami (1-2 Metern Wellenhöhe) ohne schwere Schäden. Einige Straßen wurden aufgrund von Erdrutschen gesperrt. Die Minenindustrie meldete Schäden in der Größenordnung von 10 Mio. US$.

Super Typhoon "Hagupit", Philippines

Bernhard Mühr, Tina Bessel, Trevor Girard, Susan A. Brink, Bijan Khazai, Tina Kunz-Plapp, Sven Baumstark

Introduction

Nearly one year after super typhoon "Haiyan" devastated the Philippine city of Tacloban and caused several thousand casualties, another very strong typhoon headed for the central parts of the Philippines during the first week of December 2014. The name of the typhoon was "Hagupit", on the Philippines known as "Ruby". "Hagupit" was the fourth tropical storm system of the 2014 season in the north western Pacific that reached highest category and super typhoon status. On 6 December 2014 "Hagupit" made landfall. Due to early and effective evacuation of more than 700,000 people and because of a significant decrease in the storm's intensity, the number of fatalities and the storm damage was lower than previously feared. Nevertheless, fierce winds and torrential rain of about 400 mm within 24 hours ensured considerable damage, floods and landslides: at least 18 people were killed.

Two days before landfall there was a realistic scenario that "Hagupit" could hit the same area as "Haiyan" did a year ago (Samar and Leyte, including the city of Tacloban) as a category 4 typhoon. While approaching the Philippines "Hagupit" lost intensity and finally missed the previously battered areas. CEDIMs FDA group decided to put a minor FDA activity into effect.

On 29 and 30 November "Hagupit" developed from a low pressure area that was identified just north of the equator in the area of the Federated States of Micronesia. Warm ocean water and favourable atmospheric conditions fed thunderstorm clusters that became organized.

Fig. 1: Satellite image, 4 December 2014, 02:10 UTC.
Images credit: NASA

The tropical depression was called "22W" by the Joint Typhoon Warning Center (JTWC). On the same day the depression grew into a tropical storm and was named "Hagupit" by the Japanese Meteorological Agency (JMA). On 2 December 2014 "Hagupit" strengthened into a typhoon and became the eleventh typhoon over the western Pacific Ocean in the 2014 season. "Hagupit" made its way through Micronesia and headed from near Palau towards the central Philippines and reached super typhoon status on 3 December 2014. A super typhoon has 1-min sustained winds of at least 241 kph. The typhoon showed maximum intensity on 04 December 2014 between 00 and 15 UTC with sustained winds of 287 kph. At 15 UTC the storm centre was 500 km southeast of Samar (PH) at 11N 131E. According to JMA the central pressure was 905 hPa.

During the next 36 hours while approaching Samar "Hagupit" decreased. According to PAGASA, the Philippine national weather agency, the typhoon made landfall on 6 December 2014 at 13:15 UTC near Dolores on eastern Samar. At the time of landfall, "Hagupit" was rated a category 3 typhoon on the Saffir-Simpson Hurricane Wind Scale with maximum sustained winds of 201 kph.

The storm field covered an area with a diameter of about 500 kilometres. Due to friction, the typhoon showed further weakening and made its way across the Philippines with a propagation speed of around 10 kph as a category 2 storm on 7 December 2014. "Hagupit" made its

second landfall near Cataingan on the island of Masbate.

On 8 December 2014 the typhoon was downgraded into a tropical storm and had its closest approach to the metropolitan area of Manila at around 17 UTC when the storm center passed the capital 90 km to the south. On 9 December 2014 the storm entered the South China Sea travelling to the west to southwest and finally dissipated on 11 and 12 December 2014. Remnants of the storm affected Vietnam.

Forecasting and Impacts of Super Typhoon "Hagupit"

On 3 December 2014 some forecast models still calculated a track to the northeast on which "Hagupit" would have missed the Philippines altogether.

On 4 December 2014 it was feared that "Hagupit" would make landfall as an upper category 4 typhoon near the island of Leyte and close to the city of Tacloban. Moreover, "Hagupit" would still affect Manila as a category 2 typhoon; at this time gusts of as much as 380 kph were predicted over open waters.

In contrast to the first forecasts that "Hagupit" could hit the Philippines as a super typhoon with a similar strength to that of "Haiyan" a year ago, the storm showed significant weakening from 5 December 2014 onwards. Despite a sea surface temperature of about 29°C, increased

Fig. 2: Track of Super-Typhoon HAGUPIT, 6 hourly timestep (Analysis 29 Nov - 09 Dec and forecast 09 - 12 Dec 2014). Red numbers represent the storm's category (Cat 1 – Cat 5) according to the Saffir-Simpson Hurricane scale (TD – Tropical Depression, TS – Tropical Storm). Data source: Joint Typhoon Warning Center.

vertical wind shear made "Hagupit" lose intensity rapidly.

Due to a relatively slow shift along its track, Hagupit was responsible for intense rainfall which caused landslides, flooding and falling debris. 72-hour rain amounts were 433 mm in Catbalogan (Samar), 420 mm in Masbate City (Masbate), 406 mm in Borongan (Samar) and 292 mm in Tayabas (Luzon); Manila International Airport did not get extremely heavy precipitation, recording a mere 44 mm of rain.

Figure 2 shows predicted rain amounts during a period of 144 hours while "Hagupit" crossed the Philippine islands between 5 and 11 December 2014. Along the path of the typhoon rain amounts exceeding 300 mm had been expected as well as resulting flooding and landslides.

Impacts on Transportation Systems and Lifelines

Typhoon Hagupit had some minor impacts on the transportation system. Vessels, rolling cargoes and motorbancas have been stranded due to bad weather conditions. Between 7 and 9 December 2014, a total of 245 domestic and 33 international flights were cancelled. Several roads were reported not passable because of flooding, landslides, fallen trees and toppled electric posts, some bridges were closed due to high water levels.

Power interruptions were experienced in 20 provinces in six regions, most of them occurring in the provinces of Samar and Leyte. In the telecommunication sector some networks were down but had been restored largely within two days.
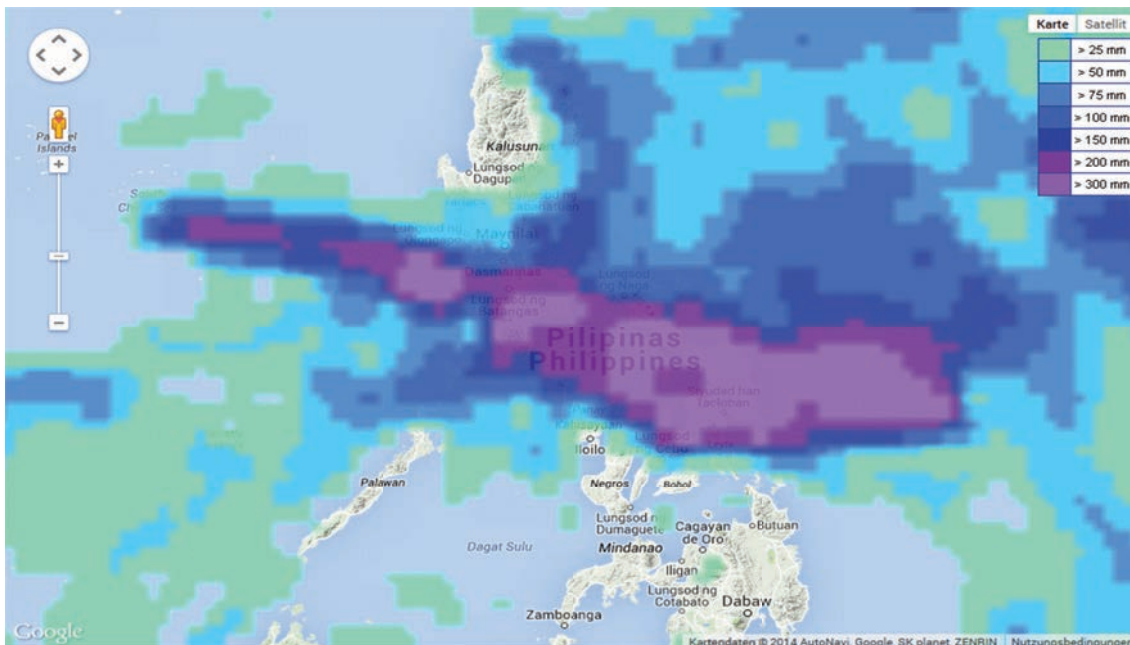
Fig. 3: 144h-precipitation amount covering 5-11 December 2014, 00 UTC.
Image credit: www.wettergefahren-fruehwarnung.de.

Disaster Preparedness and Social Impacts

Before affecting the Philippines, storm and typhoon warnings have been issued for parts of Micronesia (Woleai, Yap) on 2 December 2014 followed by tropical storm warnings for parts of the Republic of Palau (Kayangel, Koror). From December 4th - 8th the Philippine National Disaster Risk Reduction and Management Council (NDRRMC) issued an average of four Weather Bulletins per day, or one every six hours. On 6 December 2014 public storm warning signal#3

(highest warning level) was issued for parts of Regions VIII and V. The emphasis was on storm surges and "big waves", a term not used during typhoon "Haiyan".

"Hagupit" affected more than 4.000.000 people, 18 people died, 916 were injured. The evacuation focused on the eastern coast of the Philippines although evacuations occurred throughout the affected area. The large evacuation before "Hagupit" has been credited to improved preparedness as a consequence

Thursday, 4 December 2014, 10:51 UTC	Email-notification with preliminary information and advice of a possible FDA activity; FDA distribution list
Thursday, 4 December 2014, 21:00 UTC	Advance warning on website Wettergefahren-Frühwarnung
Friday, 5 December 2014, 09:00 UTC	Update of warning on website Wettergefahren-Frühwarnung
Friday, 5 December 2014, 11:36 UTC	Information of CEDIM FDA group members by email
Friday, 5 December 2014	Preliminary CEDIM activities began; checking and categorizing information about the typhoon
Saturday, 6 December 2014, 09:30 UTC	Update of warning on website Wettergefahren-Frühwarnung
Saturday, 6 December 2014, 13:15 UTC	Landfall of "Hagupit" near Dolores in Eastern Samar province, Philippines
Saturday, 6 December 2014, 13:51 UTC	Email to all members on CEDIM FDA distribution list. Decision was made that a full FDA activity was not considered inevitable due to significant decrease of storm
Sunday, 7 December 2014, 09:30 UTC	Update of warning on website Wettergefahren-Frühwarnung
Sunday, 7 December 2014, 13:35 UTC	Latest information sent by email to CEDIM FDA group
Sunday, 7 December 2014, 21:30 UTC	First analysis on typhoon's evolution on website Wettergefahren-Frühwarnung
Monday, 8 December 2014, 11:00 UTC	Final warning on website Wettergefahren-Frühwarnung
Tuesday, 9 December 2014, 11:00 UTC	Report 1 on CEDIM website (in English)
Tuesday, 9 December 2014, 23:00 UTC	Extensive analysis about Hagupit (meteorological information, historical context, impact) on website Wettergefahren-Frühwarnung (in German)
Tuesday, 9 December 2014, 23:00 UTC	FDA activity ended

Table 1: Timeline of the FDA activity concerning "Hagupit".

of learning from typhoon "Haiyan". One year ago, the much stronger Typhoon "Haiyan" led to a pre-emptive evacuation of 792,018 people compared to the 716,639 people evacuated for Typhoon "Hagupit".

A total of 290.670 damaged houses were reported with 42.466 totally damaged. According to latest situation report of NDRRMC, the overall cost of damages were about 100 Million US$, of which 29 Million US$ was related to infrastructure damage and 71 Million US$ to agriculture.

Core Science Team

Bernhard Mühr
 *Institute for Meteorology and Climate
 Research, KIT*

Tina Bessel
 Institute of Economics, KIT

Trevor Girard
Susan A. Brink
Bijan Khazai
Tina Kunz-Plapp
 Geophysical Institute, KIT

Publications

B. Mühr, T. Bessel, T. Girard, S.A. Brink, B. Khazai, T. Kunz-Plapp: Super Typhoon 22W "Hagupit" – information as of 9 December 2014, 1st report, http://www.cedim.de/download/CEDIM_hagupit2014_short.pdf, 5 pages.

B.Mühr, S. Baumstark: Tropischer Wirbelsturm Super-Taifun "Hagupit" -Philippinen http://www.wettergefahren-fruehwarnung.de/Ereignis/20141207_e.html.

Super Typhoon "Hagupit", Philippinen

Anfang Dezember 2014 erreichte Taifun "Hagupit" vor den Philippinen Super-Taifun-Status und gehörte als vierter Wirbelsturm der höchsten Kategorie an. Als Taifun der Kategorie 3 ging "Hagupit" am 06.12. an Land. Durch frühzeitige Vorbereitungsmaßnahmen und einer Abschwächung vor dem Landgang fielen die Schäden geringer aus, als zuvor befürchtet. Heftiger Wind und sintflutartige Regenfälle von zum Teil fast 400 mm in 24 Stunden sorgten dennoch für erhebliche Sturmschäden, Überschwemmungen und Erdrutsche.

Der tropische Wirbelsturm hatte für mehr als 4 Millionen Einwohner der Philippinen direkte Auswirkungen. Sie wurden in umfangreichen und frühzeitigen Evakuierungsmaßnahmen in insgesamt 327 Schutzräume gebracht. Im Gegensatz zum Taifun „Haiyan", der noch ein Jahr zuvor rund 7000 Todesopfer gefordert hatte, blieb die Zahl der Toten (18) und Verletzten (916) vergleichsweise klein. Die Schadenssumme beläuft sich auf rund 100 Millionen US$, davon entfallen 71 Millionen US$ auf Schäden in der Landwirtschaft, der Rest auf Schäden an der Infrastruktur.

Disaster Management

Continuous Long-Term Simulations for Flood Risk Assessment - Mulde Case Study

Daniela Falter, Kai Schröter, Nguyen Viet Dung, Sergiy Vorogushyn, Heidi Kreibich, Yeshewatesfa Hundecha, Heiko Apel, Bruno Merz

Introduction

There is an increasing need for spatially consistent flood risk assessments at the large scale (>10.000 km^2), since currently available approaches have several shortcomings. Flood risk assessments often use the return periods of flood flows or precipitation as a proxy for the probability of damage. Moreover, risk mapping is often undertaken assuming a uniform return period across large river basins, which may

lead to a vast overestimation of risk at large spatial scales.

Aims/Objective

The project aims at developing a novel approach for assessing flood risk in river catchments in a spatially consistent way. The approach is based on a set of coupled models representing the complete flood risk chain, including a large-scale multisite, multivariate weather generator, a hydrological model, a
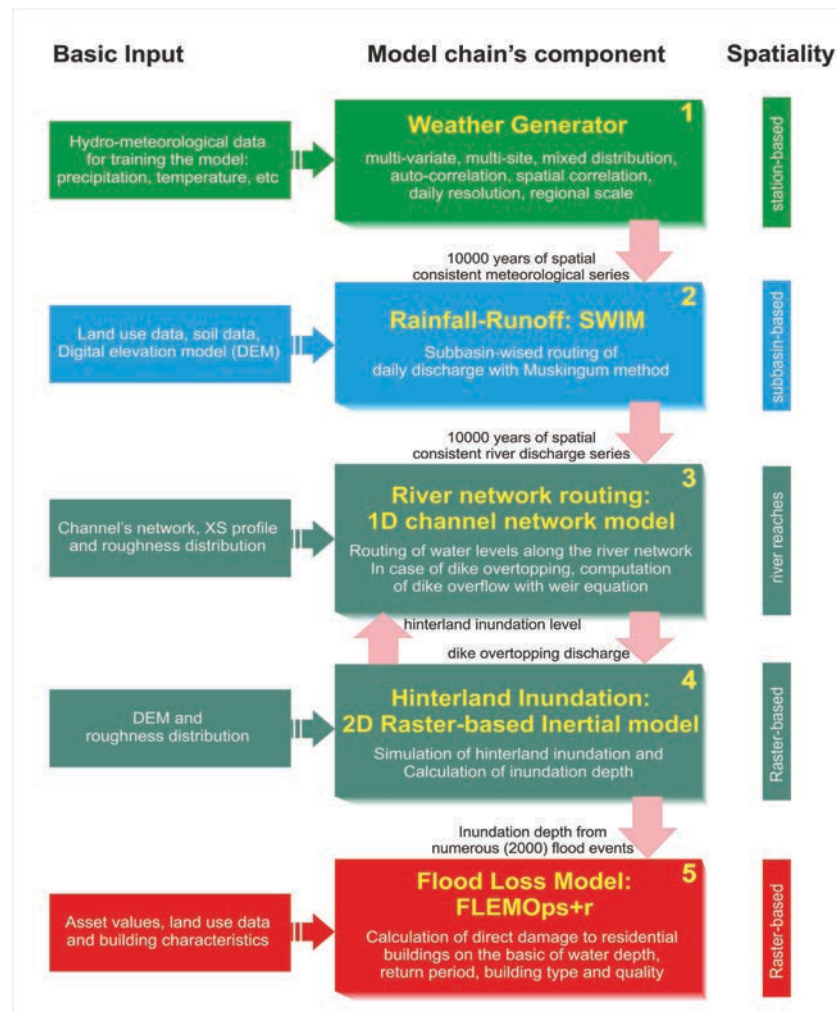

Fig. 1: Input data, components and interactions of the RFM model chain.
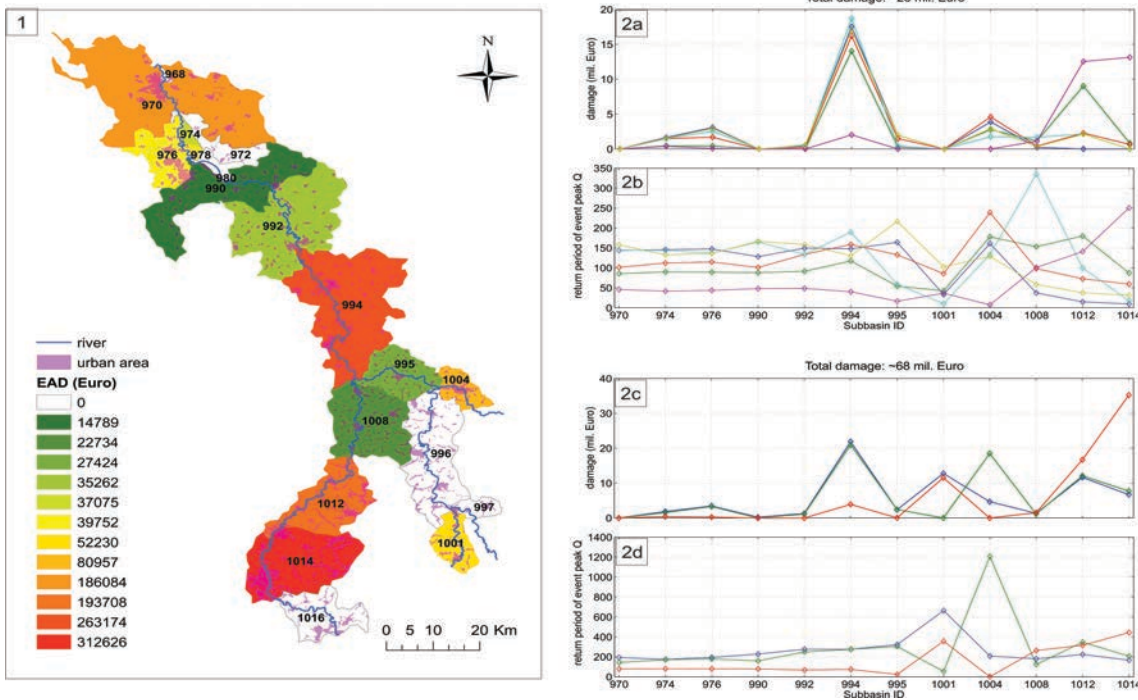
Fig. 2: 1) Distribution of Expected Annual Damage to residential buildings in the Mulde catchment at the subbasin scale. 2a) – 2d) Comparison of total damage (a, c) and discharge return period (b, d) spatial distributions among subbasins (x-axis) and different flood events (coloured lines) for two different levels of total catchment damage.

two-way coupled 1D-2D hydrodynamic simulation model and a flood loss estimation model. Long time series of spatially consistent meteorological fields are generated and transformed, through the subsequent models, into long time series of flood damage. This allows the derivation of flood risk estimates directly from the simulated damage.

Project status

The approach is based on a set of coupled models representing the complete flood risk chain, namely RFM (see Fig. 1). As an example, the approach is applied to the mesoscale catchment Mulde (ca. 6,000 km²), located in east Germany. 10,000 years (100 realizations of a 100-year period) of spatially consistent meteorological time series are generated and used as input to the model chain, yielding spatially consistent river discharge series, inundation patterns and damage values. This results in a unique data set of more than 2,000 flood events, including detailed spatial information on inundation depth and damage at a resolution of 100 m. On this basis flood risk curves and risk indicators, such as expected annual damage (see Fig. 2), can be derived for a range of spatial scales, from the grid cell to the catchment scale.

The novel flood risk approach thus developed is based on long-term continuous simulation and has a number of advantages:

1. Spatially coherent patterns of catchment meteorology, hydrology and floodplain processes,
2. Holistic representation of flood risk processes,
3. A genuine representation of damage probability, and hence, flood risk.

Outlook

The approach has great potential to be transferred to other mesoscale but also large-scale catchments. It is currently being implemented for case studies in the Saale catchment and the german part of the Elbe catchment. Moreover, dike breach process modelling and its implementation in the flood risk model chain is planned. This process has an important impact on flood impacts but is not yet considered in the hydrodynamic model components.

Core Science Team:

Daniela Falter,
Kai Schröter,
Nguyen Viet Dung,
Sergiy Vorogushyn,
Yeshewatesfa Hundecha,
Heidi Kreibich,
Heiko Apel,
Bruno Merz
 Section 5.4 Hydrology, GFZ

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Kontinuierliche Langzeitsimulationen zu Flut-Risikobewertung - Multi-Case Studie

Es wird ein neuer innovativer Ansatz zur räumlich konsistenten Abschätzung des Hochwasserrisikos in Flusseinzugsgebieten präsentiert. Der Ansatz basiert auf gekoppelten Modellen die die gesamte Hochwasserrisikokette abdecken: ein großräumiger, multi-site, multivariater Wettergenerator, ein hydrologisches Modell, ein wechselseitig gekoppeltes 1D-2D hydrodynamisches Simulationsmodell und ein Hochwasserschadenmodell. Lange Zeitreihen räumlich konsistenter meteorologischer Felder werden erzeugt und durch die Modellkette in lange Zeitreihen von Hochwasserschäden transformiert. Somit kann das Hochwasserrisiko direkt auf Basis des simulierten Hochwasserschadens ermittelt werden.

The Web Service „Wettergefahren-Frühwarnung" (Weather Hazards – Early Warning)

Bernhard Mühr

Overview

The key aspect of the internet service "Wettergefahren-Frühwarnung" is extreme weather events, especially when they are associated with a high potential for loss and damage. The main focus is on Europe, but severe natural disasters on other continents are also considered and investigated. The web platform "Wettergefahren-Frühwarnung" has been operational for more than eleven years now and has become a flagship of CEDIM. Permanent availability, daily updated information, automatically calculated forecasts worldwide, editorially enhanced reports of extreme or unusual weather events and a comprehensive and ever-growing archive of nearly 1000 events are the hallmarks of the project. Additionally, "Wettergefahren-Frühwarnung" is a pillar in CEDIM's strategy of interdisciplinary research in analyzing natural disasters in near real-time. And in the context of ATMO Forensic Prediction and Analysis, an operational forecast system for winter storms in Germany will be developed.

Notable extreme weather events in 2014

51 unusual or extreme weather events have been identified and analyzed by "Wettergefahren-Frühwarnung" in the course of the year 2014. According to the goals and the mission of "Wettergefahren-Frühwarnung" which puts the focus on Europe, 22 of the events affected European countries or countries bordering the Mediterranean Sea.

Apart from super typhoon "Hagupit" that crossed the Philippines and required a minor CEDIM FDA activity (see this issue), some of the extreme weather events are particularly worth mentioning:

1.) Heavy snowfall and extreme cold spell in North America beginning of 2014

Strong winds, heavy snowfall and extreme low temperatures struck parts of Canada, the Midwest, the northern Plains and the north eastern states of the US. Minimum temperatures of around -40°C and blizzard-like conditions caused severe impairment and at least 20

deaths. Several arctic blasts until early March made the winter 2013/2014 extremely cold with negative temperature anomalies exceeding 5K in parts of the north eastern half of North America.

2.) Severe flooding in Balkan States, May 2014

While in many parts of Europe spring 2014 turned out to be exceptionally dry, lots of stations in south east Europe recorded rain amounts about two and a half to three times the usual amount. In mid May, another quasi-stationary upper low pressure system over south east Europe caused persistent and intense rainfall that finally led to extreme floods in the Balkans. Bosnia and Herzegovina and Serbia experienced a hundred year flood, at least 44 people were killed.

3.) Heat wave and severe thunderstorms in Central Europe, June 2014

Right during Pentecost 2014, hot air of African origin was responsible for the first heat wave of the year in Central Europe. High temperatures were well above 35°C at many places, numerous temperature records for the first decade of June or even for the entire month were broken. In Germany, Rheinau-Memprechtshofen in the valley of the river Rhine experienced 37.7°C: similarly high temperatures did not occur in the rest of the year throughout the country. The heat-wave ended with severe thunderstorms that developed over Benelux, France and parts of Germany. In North Rhine-Westphalia the thunderstorms were accompanied by extreme wind gusts that reached 144 km/h in Düsseldorf and were responsible for severe damage: 7 people died. One tree out of four was buckled or uprooted, railway traffic was disrupted, and on the streets there were 300 km of traffic jams.

4.) Intense rain, thunderstorms and flooding in the western and central Mediterranean Sea, autumn 2014

A series of high impact weather events battered eastern Spain, southern France, southern Switzerland and Italy. Due to constant moisture supply from the nearby Mediterranean Sea and
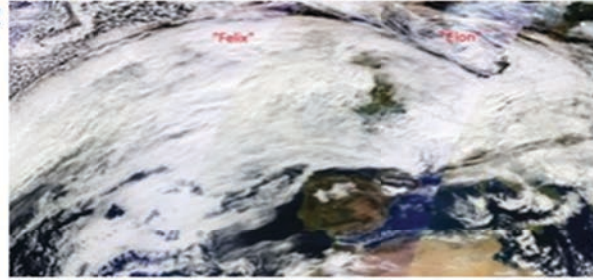
Samstag, 10. Januar 2015, 00:45 MEZ
zuletzt aktualisiert: 11.01.2015, 21:00 MEZ

Winterstürme "Elon" und "Felix"

West-/Mitteleuropa

09.-10.01.2015

Satellitenbild (Terra MODIS)
09.01.2015, gegen 12 UTC
Quelle: NASA Worldview

Zu Beginn des Jahres 2015 stellte sich nach einem kurzen Wintereinbruch Ende Dezember 2014 eine stürmische Wetterlage in West- und Mitteleuropa ein. In einer zonalen Strömung verlagerten sich Randtiefs mit hoher Geschwindigkeit ostwärts. Nach Sturmtief "Elon" am 09.01. stand für den 10.01. über dem Nordatlantik bereits "Felix" in den Startlöchern. "Elon" brachte auf den Britischen Inseln und an der Nord- und Ostseeküste sowie im Bergland Orkanböen. Im schottischen Stornoway wurden Spitzenböen bis 182 km/h registriert. In den Grampian Mountains wehte der Wind in Böen bis 225 km/h (Cairngorm Summit, 1237 m).

Im Warmsektor von "Felix" wurde am Alpenrand die 20 °C-Marke überschritten und für ein paar neue Rekordtemperaturen aufgestellt. "Felix" sorgte im Nord- und Ostseeumfeld sowie im Bergland verbreitet für Orkanböen. Im Süden Norwegens wehte der Wind auf der Insel Eigeroya bis 166 km/h. Auch in Norddeutschland, Dänemark und Südschweden wurden Orkanböen gemessen. Windbedingte Schäden zeigten sich vor allem durch beschädigte Dächer und umgestürzte Bäume, die zu Verkehrsbehinderungen führten. An der Nordseeküste hatte mit kam es zu einer Sturmflut.

Sturmtief "Elon"

Wetterlage und Entwicklung

Im Verlauf der ersten Januardekade 2015 stellte sich über West- und Mitteleuropa eine zonales Zirkulationsmuster mit sehr windigem Wetter ein. Am 06.01. und an den Folgetagen verlagerte sich ein langwelliger Trog über dem Nordatlantik ostwärts. Das zugehörige Bodentief "Christian", das am 06.01. über dem östlichen Nordatlantik die Rolle des steuernden Zentraltiefs einnahm, erreichte am 07.01. mit einem Kerndruck knapp unter 940 hPa westlich von Island seinen Höhepunkt. Im Zusammenspiel mit einem sich aufbauenden Bodenhoch, das bis zum 09.01. einen Kerndruck von 1045 hPa aufwies, enstand über Zentraleuropa ein beachtlicher Druckgradient.

Bodendruckanalysen und Satellitenbilder | Quellen: FU Berlin/DWD, B. J. Burton

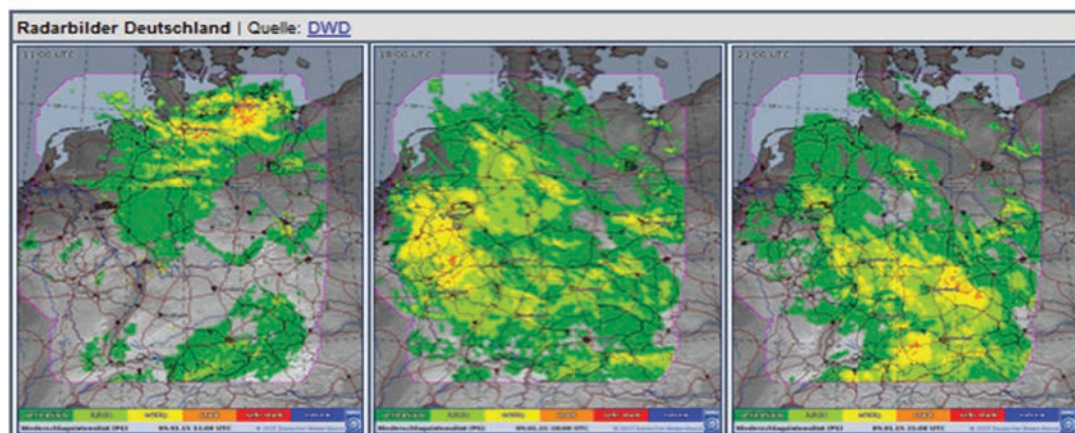| Bodendruckanalyse vom 08.01., 00 UTC | Satellitenbild vom 08.01., 12 UTC | Bodendruckanalyse vom 09.01., 00 UTC | Satellitenbild vom 09.01., 12 UTC |

Radarbilder Deutschland | Quelle: DWD

Fig. 1: Screenshot of "Wettergefahren-Frühwarnung": Analysis of winter storms "Elon" and "Felix" in Western and Central Europe, January 2015.
Image credit: http://www.wettergefahren-fruehwarnung.de.

favorable meteorological conditions, thunderstorms and areas with heavy rain were able to regenerate and led to enormous rain amounts.

And the end of September Montpellier received 250 mm of rain within 3 hours - a new record. The long-term monthly rain average for September is only 80 mm. According to Meteo-France it had not rained that much in 11 years in the region and a state of disaster was declared.

In early November an intense cyclogenesis caused heavy rain between the western Mediterranean Sea and the Alps. France, Italy and Austria received several 100 mm of rain within a short time resulting in landslides and flooding. An extraordinary rain amount of nearly 700 mm (689 mm within 48 hours) occurred in north-eastern Italy at Malga Valine. At higher elevations of the Alps gale-force winds were measured, Chamrousse (F) reported wind gusts of even more than 200 kph. Further to the south, between Tunisia and Sicily, the low pressure system "Quendresa I" became a so-called "Medicane" and caused considerable damage on Malta and on Sicily.

A few weeks later, during another heavy rain event. 361 mm of rain fell within 12 hours at Passo de Giovi north of Genoa (Italy), Genoa itself observed 459 mm within a week (November 9-16) which is four times the usual amount for November. Entire districts were under water, landslides made roads and railroad tracks impassable. An extraordinary high water level of Lake Maggiore and Lake Lugano (Switzerland) required the highest warning level.

FDA – Forensic Disaster Analysis

Meteorological aspects play an important role before, during and after a natural disaster event, regardless of what type of disaster. On the one hand, meteorological extreme events are the most common natural disasters that occur globally; on the other hand, there are many interactions and inter-dependencies of local meteorological conditions that impact the social, economic and infrastructure sectors during or after non-meteorological events. The project "Wettergefahren-Frühwarnung" supports all FDA activities by the preparation of text, data, information or graphics. When appropriate, FDA activities are initiated or the leading role is taken.

Cooperation with and assistance of other projects inside and outside of CEDIM.

For example, projects such as Rapid Flood Event Analysis, Transportation Interruption or Database and Implementation of Case-Based Reasoning for Analytical Support all benefit from "Wettergefahren-Frühwarnung" activities. For these projects data is generated and made available. For a rapid flood analysis own high-resolution model forecast data might be calculated or measurement data will be provided and also the project of transport interruption may use forecast or measurement data on a daily routine.

Other duties include a close cooperation with external companies, e.g. insurances, for which information and products are made available. In addition, some work has to be done in the media sector (Television, radio broadcasting, newspapers or news agencies), but also other scientific institutions take advantage of particular products.

Core Science Team

Bernhard Mühr
Institute for Meteorology and Climate
Research, KIT

Publications

www.wettergefahren-fruehwarnung.de

www.vorhersagezentrale.de

Der Web-Service "Wettergefahren-Frühwarnung"

Seit mehr als 11 Jahren informiert die Internet-Plattform "Wettergefahren-Frühwarnung" tagesaktuell über bevorstehende ungewöhnliche oder extreme Wetterereignisse, vor allem dann, wenn sie mit einem großen Schadenpotential einhergehen. Das Informationssystem umfasst einerseits Warnungen und Hinweise bereits einige Tage vor Eintritt des Ereignisses und andererseits redaktionell aufbereitete und mit Texten, Tabellen, Grafiken und Daten versehenen Artikel, die nach Ende der Wetterereignisse verfasst werden. Das einzigartige

Archiv umfasst mittlerweile Analysen zu fast 1000 Wetterereignissen weltweit. Ständige Verfügbarkeit, Aktualität, Qualität und Umfang sowohl des Archivs als auch der aktuellen Informationen sind die Markenzeichen des Projekts, das sich auch zu einem Aushängeschild für CEDIM entwickelt hat.

"Wettergefahren-Frühwarnung" unterstützt und arbeitet mit anderen Projekten innerhalb und außerhalb von CEDIM zusammen. Als Beispiele seien genannt: Rapid Flood Analysis, Transportation Interruption oder Database and Implementation of Case-Based Reasoning for Analytical Support. Für alle diese Projekte werden Daten erzeugt und bereitgestellt. Wei-

tere Aufgaben umfassen die Zusammenarbeit mit externen Unternehmen (Versicherungen), Medien und anderen wissenschaftlichen Einrichtungen.

Im Rahmen der Forensischen Katastrophenanalysen (CEDIM Forensic Disaster Analysis, FDA) spielt "Wettergefahren-Frühwarnung" eine wichtige Rolle, indem es sämtliche FDA-Aktivitäten durch Bereitstellung von Texten, Daten, Informationen und Grafiken unterstützt. Im Falle meteorologischer Naturkatastrophen leitet "Wettergefahren-Frühwarnung" die FDA-Aktivitäten ein und führt sie gegebenenfalls auch in leitender Funktion durch.

The Challenge of Hail Hazard and Risk Modelling

Michael Kunz, Heinz Jürgen Punge, Manuel Schmidberger, Susanna Mohr, Elody Fluck
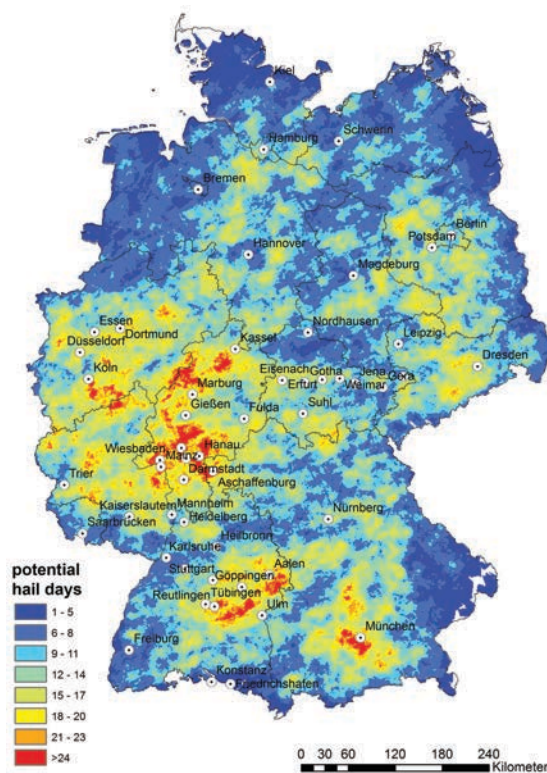

Fig. 1: Number of days between 2005 and 2013 with hail signals in the three-dimensional radar data of the DWD radar network (Schmidberger et al., 2014).

Overview

The recently published damage statistics of Munich Re for the year 2013 reveal a surprising finding: The costliest natural catastrophe worldwide - ranked by insured losses - was a hailstorm event in Germany. On 27/28 July, two supercell thunderstorms – one that moved over the central parts, the other over southwest Germany – with hailstones of up to 8 cm diameter caused insured losses of 3.1 bn € (economic loss: 3.1 bn €). This example illustrates the large damage potential related to hail events, which is still underestimated both by the public and the insurance industry. In the context of CEDIM, different projects are currently carried out at IMK-TRO/KIT with the aim to better understand hail probability, hail risk and possible trends. This article gives a brief overview of the main results.

Hail Hazard Assessment

The assessment of the hail hazard is challenging mainly for two reasons: The areas affected by hail, referred to as hail streaks, are usually very small, and direct observational data are

not available. To tackle this problem, appropriate methods that estimate hail probability and intensity from indirect data, so-called proxies, have to be developed and implemented. Most suitable are observations from remote sensing instruments such as radar, satellite, or lightning sensors having a large area under constant surveillance. These data sets can be complemented by additional information from regional climate models (RCM) that are available for longer periods.

For the area of Germany, we derived hail signals from three-dimensional radar data from the German Weather Service (DWD) radar network, filtered additionally with lightning observations and tracked with a specific algorithm. The result is a unique high-resolution radar-based event set consisting of around 10 000 individual hail streaks. The analyses reveal that the spatial distribution of the hail events is the result of a superposition of large-scale climatology and local-scale flow dynamics (Fig. 1). A surprising finding is that most of the hail maxima are located downstream of the low-mountain ranges. Additional simulations with the numerical weather prediction model COSMO-DE of DWD confirm that flow convergence at lower levels emerging downstream of the mountains play a major role in the spatial distribution of the hail events.

To estimate the hail probability across Europe, we employed satellite-derived infrared brightness temperature as proxy for hail. Overshooting of air masses atop thunderstorm anvil clouds (overshooting top, OT) with low cloud top temperatures has proven to be a reliable indicator of severe thunderstorms including hail. In combination with hail reports archived by the European Severe Weather Database (ESWD), the OT observations are used to build a "climatology" of hail events in Europe. Highest OT frequencies found in regions adjacent to the Alps, the Pyrenees and near the Massif Central confirm the relation between topography and hailstorm frequency (Fig. 2).

Hail Risk Modelling

Risk modeling in general requires large event samples over a long-term period. This applies in particular for the estimation of the probable maximum loss of a 200-years event (PML200), which insurers need to provide in the context of regulatory directives such as Solvency II. The hail risk models developed at KIT for the insurance industry (SV SparkassenVersicherung

AG, Willis Re, Tokio Millennium) are based on stochastic event sets for which track properties such as length and width, duration, orientation and intensity are generated from statistical distribution functions derived from past observed events.

The recently developed HARIS-SV hail loss model is based on the Gutenberg-Richter recurrence law known from earthquake modelling. This approach combines return periods of hailstorms with historical hailstone sizes from ESWD on a 10 x 10 km2 grid. The stochastic event set is created from polygons that are randomly constructed from the radar-derived event set. These polygons are the basis for the calculation of the PML for a given portfolio. Additionally, hazard and vulnerability are combined with a damage function to separate different damage classes for every building object class. Expected damage is obtained from the accumulation of the mean damage ratio for a specific portfolio. The model works efficiently and also predicts realistic overall losses for single events such as that of 28 July 2013.

The recently introduced Willis European hail model (WEHM) uses a satellite-based historical event set to define the spatial extent and intensity of hail events, also complemented by ESWD hail reports. More than 1 million individual events are simulated with the help of stochastic methods. Thereby an accurate representation of the relationship of event length, width and severity was implemented in the model. The final stochastic hail event catalogue
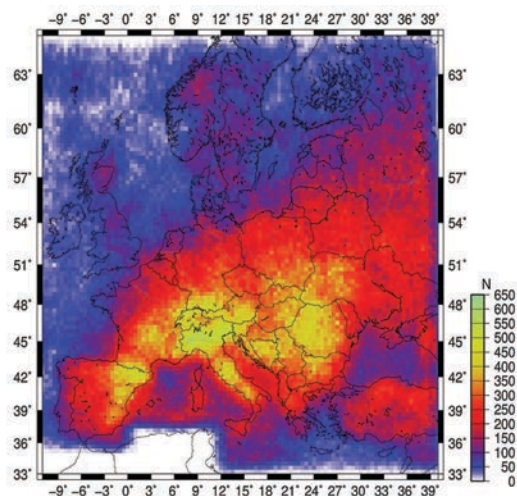

Fig. 2: Spatial distribution of the stochastic hail event centroids derived from overshooting top satellite data at a resolution of 0.5° x 0.3° between 2004 and 2011 (Punge et al., 2014).

(hazard module) is the first with a spatial event distribution that is based on a single homogeneous observation source over Europe. The risk part of WEHM, including the description of appropriate damage function, was developed at Willis Re. The WEHM is currently used by more than 20 insurance companies.

Long-Term Variability of Hail Events

The temporal variability of hailstorms over long time periods is examined using a logistic hail model (multivariate analysis). This approach combines different meteorological parameters relevant for thunderstorm and hailstorm development (e.g., convection energy, moisture content, large-scale weather conditions). The result of the logistic hail model is a new index, referred to as potential hail index (PHI), which describes the potential of the atmosphere for the formation of hailstorms. Based on regionalized ERA-40 reanalyses over past decades, PHI shows a distinct north-to-south gradient in Germany with maximum in the south. The analyses confirm that the hail potential of the atmosphere increased between 1971 and 2000, even though statistical significance is below 95% at most of the grid points. According to an ensemble of seven RCMs (including those from the former CEDIM project Flood Hazard in a Changing Climate), it can be expected that the potential for hail events will rise slightly in the future (2021-2050), particularly in Northwest and Southern Germany (Fig. 3).
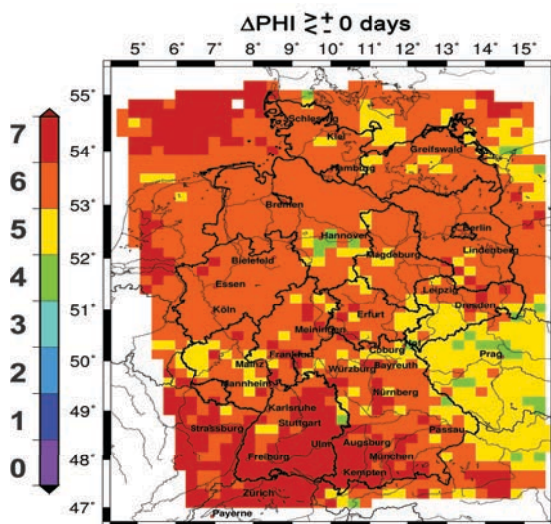

Fig. 3: Changes of the potential hail index PHI between 2021-2050 and 1971-2000 on the basis of an ensemble of seven regional climate model simulations. The colors indicate the persistence of the signal by the number of model runs (out of seven) that project an increase in PHI (Mohr et al., 2015).

Conclusions

In recent years, hail damage in Europe has increased substantially. In several regions such as Southern Germany, Switzerland, or Austria, hail causes the major share of insured losses by natural hazards to buildings and agriculture. Despite the considerable damage potential, hail risk is still underestimated by the public and the insurance industry. Only a few hail models are currently available in the insurance market.

In cooperation with the insurance industry, different hail risk models are developed at KIT. Apart from the quantification of risk measures such as the PML200, the hail hazard assessments also provide new scientific insights. One example is the increased hail frequency found downstream of low mountain ranges, which can be plausibly explained by flow characteristics prior to hail events.

The question whether the series of severe hailstorms over the last couple of years in Europe is the result of a changing climate or natural variability alone cannot be answered directly. However, our climate model analysis gives some indications that suggest an increase in the hail potential of the atmosphere over past and future decades.

Besides the various research activities in the context of hail, it is planned to combine our hail detection methods in future with information provided by the CEDIM crowd sourcing project. This should help to better estimate hail sizes, which are directly related to damage, and to support CEDIM FDA activities where hail plays a major role.

Acknowledgement

Core Science Team

Michael Kunz
Heinz Jürgen Punge (WRN Fellow)
Manuel Schmidberger
Susanna Mohr
Elody Fluck
 *Institute for Meteorology and Climate
 Research (IMK-TRO), KIT*

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Herausforderung Hagelmodellierung

Infolge des starken Anstiegs von Hagelschäden in den vergangenen Jahren in Europa werden in einigen Regionen mittlerweile die meisten versicherten Elementarschäden an Gebäuden und in der Landwirtschaft durch Hagel verursacht. Trotz des außerordentlich hohen Schadenpotentials durch schweren Hagel - beispielsweise haben die Hagelstürme am 27./28. Juli 2013 in Deutschland mit 3.1 Mrd. € die höchsten versicherten Schäden durch Naturkatastrophen weltweit verursacht – wird das Hagelrisiko noch immer von der Gesellschaft und auch der Versicherungsindustrie unterschätzt.

In Kooperation mit verschiedenen Versicherungen und CEDIM wurden am IMK-TRO/KIT verschiedene Hagelgefährdungs- und Schadenmodelle für Deutschland, Mitteleuropa und Europa entwickelt. Da praktisch keine direkten Hagelmessungen verfügbar sind, wurden hierfür Fernerkundungsdatensätze wie Radardaten, Satellitendaten und Messungen von Blitzsensoren verwendet. Neben der Abschätzung des Hagelrisikos, beispielsweise des wahrscheinlichen maximalen Schadens für ein 200-jährliches Ereignis, zeigen die verschiedenen Analysen auch neue und wichtige wissenschaftliche Ergebnisse, beispielsweise die Häufung von Hagelereignissen stromab der Mittelgebirge. Mit Hilfe eines speziell entwickelten logistischen Regressionsmodells konnte außerdem gezeigt werden, dass die Wahrscheinlichkeit für die Entstehung von schweren Hagelstürmen in der Vergangenheit in Deutschland zugenommen hat und in der Zukunft weiter (leicht) ansteigen wird.

Vulnerability and Critical Infrastructures

Decision Support Methods in the Field of Critical Infrastructure Protection (DSM CIP): Overview

Thomas Münzberg, Stella Möhrle, Wolfgang Raskob

Fig. 1: Participants in the two-day expert workshop 'disaster management planning for food shortages and power outages' at the National Research Center of the Karlsruhe Institute of Technology.

Introduction

Critical Infrastructure Protection (CIP) covers all activities that ensure a continued supply of vital services and products for the population. This includes all coping measures to mitigate and to minimize the consequences of CI disruptions before and during disasters as well as to recover from the effects to get back to a satisfying supply status.

With the focus on disaster management and emergency planning, the CEDIM project 'Decision Support Methods in the Field of Critical Infrastructure Protection (DSM CIP)' promotes the development of decision support methods and analysis approaches for numerous CI related threats. In 2014, we were able to build on the successes of the previous years and further improved our research activities on various decision support methodologies, such as case-based reasoning, multi-criteria decision analysis, indicator-based vulnerability analysis, and agent-based simulation.

Aims / Objective

Our long-term strategy aims at developing an integrated decision aiding system that supports decision makers from different administrative levels of disaster and emergency management. For this purpose, our research activities address various decision support approaches in order to manage different threat scenarios in different CI sectors.

Project status

In the last year, we have expanded our research activities in the ongoing projects which focus on

- the development of a CEDIM database and the implementation of case-based reasoning (CBR),
- a simulation-based decision support to manage food shortages (SEAK),
- facilitating the selection of security measures in the context of terrorist threats

Project Name	Funding Body
Development of a CEDIM Database and Implementation of **Case-based Reasoning** for Analytical Support – Continuation From 2013	Center for Disaster Management and Risk Reduction Technology (CEDIM)
RIKOV Project: Risks and Costs of **Terrorist Threats** against Public **Rail Transport Systems** – Continuation From 2013	German Federal Ministry of Education and Research (BMBF), German National Security Research Framework
SEAK Project: Decision Support for Managing Disruptions in **Food Supply Chains** – Continuation From 2013	German Federal Ministry of Education and Research (BMBF), German National Security Research Framework
Modeling and Simulation of Critical Infrastructures using **Agent-Based Modeling** – Continuation From 2013	Helmholtz Association of German Research Centres (HGF)
Critical Infrastructure Disruption: Decision Support Through **Vulnerabilities Assessments** – Continuation From 2013	Helmholtz Association of German Research Centers (HGF)

Table 1: Projects within the DSM CIP activites in 2014 and its funding bodies.

against public rail transport systems (RIKOV),

•   the modeling of CI interdependencies through agent-based simulation (HGF Portfolio Security Research), and

•   vulnerability assessments to manage the impact of CI disruption.

In 2014, CBR has been further implemented within CEDIM's Forensic Disaster Analysis (FDA) activity (see 'Development of a CEDIM Database and Implementation of Case-based Reasoning for Analytical Support – Continuation from 2013'). Further, an agent-based model focusing on healthcare and water supply infrastructure is being developed (see 'Modeling and Simulation of Critical Infrastructures using Agent-Based Approach'). Within the SEAK project, the decision support framework for food shortages has been further enhanced based on three threat scenarios (see 'The SEAK Project: Decision Support for Managing Disruptions in Food Supply Chains – Continuation from 2013'). Within the RIKOV project, a knowledge database, a risk assessment approach, and a decision support method for prioritizing security measures in counterterrorism have been developed. (see 'Risks and Costs of Terrorist Threats against Public Rail Transport Systems – Continuation from 2013'). Further, our research on measuring CI disruption impacts has been expanded by temporal considerations (see 'Understanding Resilience: Spatial-Temporal Vulnerability Assessment– Continuation from 2013').

To support the research, we continuously improved our cooperation with end-users by offering several workshops. Embedded in the RIKOV project, we conducted an expert workshop in April 2014 on the evaluation and management of risks, with 27 participants.

A further two-day expert workshop was organized at the end of October 2014. The workshop addressed disaster management planning for food shortages and power outages at the local level. For this purpose, all city departments responsible for disaster management and health in Baden-Württemberg, as well as representatives from the regional councils in Baden-Württemberg and from the relevant German federal authorities were invited. In a synergistic way, we focused on research activities from the two HGF-projects on agent-based modelling and vulnerabilities assessments as well as on the BMBF-project SEAK. The large number of experts allowed us to conduct various surveys and discussions to improve our methodological approach and the practical implications of the research activities. The results will be analyzed and several publications are foreseen for 2015. In addition, the cooperation with end-users such as fire brigades and disaster management authorities has been strengthened for upcoming research projects.

Outlook

The individual DSM CIP activities will continue. The existing synergies between the projects will be expanded aiming to integrate new components. In addition, new projects focusing on additional CI related threats and the management of disruption effects are envisaged.

Publications

Moehrle, S. (2014): On the Assessment of Disaster Management Strategies. In: ISCRAM 2014 Conference Proceedings, Book of Papers, 11th International Conference on Information Systems for Crisis Response and Management, Hiltz, S.R., Pfaff, M.S., Plotnick, L., Shih P.C. (Ed.), The Pennsylvania State University, USA, ISBN 978-0-692-21194-6.

Münzberg, T., Motzke, A., Wiens, M., and Schultmann, F. (2014): Disruptions of Food Supply Chains: A Spatial Vulnerability Assessment Approach for Disaster Management. In: Proceedings of the 9th Future Security, Security Research Conference, Berlin, September 16-18, 2013, Thoma, K., Häring, I., Leismann, T. (Eds.) Stuttgart: Fraunhofer Verlag, 2014, pp. 48-55, ISBN: 978-3-8396-0778-7.

Methoden der Entscheidungsunterstützung zum Schutz Kritischer Infrastrukturen (DSM CIP)

Der Schutz Kritischen Infrastrukturen (KRITIS) beinhaltet alle Maßnahmen die in Krisenfällen zu einer kontinuierlichen Versorgung der Bevölkerung mit lebenswichtigen Dienstleistungen und Produkten führen. Durch die Maßnahmen werden Beeinträchtigungen oder Ausfälle der KRITIS vermieden oder minimiert sowie eine zügige Wiederherstellung des Normalzustandes nach einem Schadensereignis sichergestellt. Um hierbei insbesondere KRITIS-Betreiber und die kommunale Gefahrenabwehr zu unterstützen, werden bei der CEDIM-Aktivität „Entscheidungsunterstützung zum Schutz Kritischer Infrastrukturen (DSM CIP)" verschiedene Methoden der Entscheidungsunterstützung und Analyseansätze erforscht. In mehreren Projekten werden unterschiedliche KRITIS-Sektoren betrachtet und Methoden des fallbasierten Schließens, der multikriteriellen Entscheidungsanalyse, der Indikatoren-basierten Vulnerabilitätsanalyse und der agentenbasierten Simulation weiterentwickelt. Die Projekte spiegeln unterschiedlichste Bedrohungsszenarien wie terroristische Anschläge im öffentlichen Nahverkehr, Lebensmittelengpässe oder langanhaltende und großflächige Stromausfälle wider. Langfristig sollen alle untersuchten methodischen Ansätze zu einem umfassenden Entscheidungsunterstützungssystem integriert werden. Um den Anwendungsbezug sicherzustellen, wurden im Jahr 2014 mehrere Workshops organisiert. Bei einem zweitägigen Workshops im Herbst mit dem Thema „kommunale Notfallplanung für Lebensmittelengpässe und Stromausfälle" konnten nicht nur verschiedene Forschungsfragen der unterschiedlichen Forschungsprojekte synergetisch bearbeitet sondern auch der Anwendungsbezug und die praxisorientierte Forschung gestärkt werden.

DSM CIP: The RIKOV Project, Risks and Costs of Terrorist Threats Against Public Rail Transport Systems – Continuation from 2013

Lijun Lin, Stella Möhrle, Wolfgang Raskob

Introduction

The project RiKoV is part of the national research program Research for Civil Security - Security Economics and Security Architecture, initiated and financed by the Federal Ministry of Education and Research (BMBF).

Aims/Objective

The research aim of RiKoV is the investigation - exemplarily for all critical infrastructures - to what extent a holistic risk management approach can enhance the protection of public railway transportation systems against terrorist attacks. For this purpose, the following subsidiary aims will be pursued:

1. the analysis of historic events and the identification of plausible attack scenarios of public railway transportation,
2. the provision of a method for the analysis and assessment of terrorist risk against public railway transportation systems,
3. the provision of decision support methods for the identification and prioritization of suitable security measures considering costs and socio-political aspects to reduce the risk, and
4. the provision of decision support tools for the implementation of security measures and concepts.

The methods and tools so developed will be implemented in demonstrations.

Project Status

We focused this year on the development of a knowledge database for the structured storage of identifiable scenarios and historic attacks, the development of a risk assessment approach, and a decision support method for prioritizing security measures. For this purpose, all the attributes relevant to describe terrorist attack events were collected and analyzed. Afterwards, a database was established and filled with data from historic events and scenarios defined within this project. Further-more, a risk assessment approach was developed, which takes threat, vulnerability, and consequences of terrorist attacks into account. In the decision-making process for prioritizing security measures, the method of casebased reasoning (CBR) and a multi-criteria analysis approach (MCDA) were used. The implementation of CBR should provide an IT-based support for preselecting security measures for current attack scenarios with the usage of information of the knowledge base. MCDA supports the prioritization of retrieved security measures in a multi-criteria manner by means of attribute trees, which contain all relevant criteria for assessing security measures. The methods and the decision tree were evaluated during the expert workshop in April this year.

The CBR application and MCDA tool were set up. They are programmed in Java.

Outlook

The CBR application will be tested and the implementation process continues. The CBR application and MCDA tool will be added to the KIT demonstration. Finally, all software products will be integrated into an overall RiKoV demonstration, which will be tested using realistic scenarios.

Core Science Team

Lijun Lin
Tim Müller
Stella Möhrle
Wolfgang Raskob
Thomas Münzberg
Andreas Motzke
Stefan Wandler
Evgenia Deines
 Insitute for Nuclear and Energy Technologies (IKET), KIT

Sascha Meng
Frank Schultmann
Marcus Wiens
 Institute for Industrial Production (IIP), KIT

Publications

Lin, L., Moehrle, S., Münzberg, F. and Raskob, W. (2014): A decision Support approach: evaluating the effectiveness of security measures by scenario-based multi-criteria analysis. In 9th Security Research Conference, Berlin, September 16th – 18th.

RIKOV Projekt: Risiko und Kosten von terroristischen Handlungen gegen öffentliche Schienentransport Systeme - Fortsetzung von 2013

Das Verbundprojekt „RiKoV" beschäftigt sich mit Risiken und Kosten terroristischer Bedrohungen des schienengebundenen öffentlichen Personenverkehrs und hat zum Ziel, einen ganzheitlichen Risikomanagement-Ansatz zum besseren Schutz vor terroristischen Anschlägen zu entwickeln. Im Rahmen eines solchen Ansatzes werden historische Anschläge analysiert und plausible Bedrohungsszenarien identifiziert. Die Szenarien werden einer Risikobewertung unterzogen, welche die Bedrohung, Vulnerabilität und Konsequenzen eines Anschlags berücksichtigt. Zur Risikoreduzierung werden Sicherheitsmaßnahmen ermittelt und hinsichtlich ihrer Kosten, ihrer Wirksamkeit sowie ihrer gesellschaftlichen Akzeptanz bewertet. Dazu wird eine Entscheidungsunterstützungsmethode entwickelt, die die Sicherheitsmaßnahmen unter Berücksichtigung von Mehrzielentscheidungen priorisiert.

Die Hauptforschungstätigkeiten dieses Jahres lagen auf der Weiterentwicklung von Methoden zur Szenario-basierten Risikobewertung und Entscheidungsunterstützung. Eine Wissensdatenbank, das fallbasierte Schließen und die multikriterielle Entscheidungsanalyse wurden zu einem Entscheidungsunterstützungssystem zusammengeführt. Dieses System wird als Teil eines Demonstrators realisiert.

Strategic Deterrence of Terrorist Attacks

Sascha Meng, Marcus Wiens, Frank Schultmann

Introduction and objective

Since 9/11 terrorist threats are much more present in the European countries' preventative security and intelligence strategies. However, research and management of adversarial risks is still dominated by methods which do not sufficiently account for the terrorists' motives and for the strategic component of the interaction between offender and defender. In this research project we analyze the interplay between conventional risk analysis and game-theoretic reasoning in the context of adversarial risks. Part of this work is conducted in the context of the accompanying research project RIKOV.

Project description and outlook

The potential shortfall of conventional risk management approaches lies in the problem that history-oriented projections can also be anticipated by terrorist offenders so that they optimally adapt to this defense-system. As a result, the system's vulnerability and the offender's intention are both partly endogenous. The game-theoretic analysis contributes to a more robust defense-system in at least three ways: Firstly, it urges the researcher to investigate possible intentions and motivations of the offender by carving out a clear motivation structure of potential 'types' of offenders. Secondly, game-theoretic reasoning takes some kind of

'illusion of control" from the defending institution by compelling the important insight that there are inevitably natural limits to risk reduction due to limited resources. In the end, the most vulnerable parts are the system's limits. Although potential offenders will not be able to infer the optimal defense strategy they will be able to make an appropriate guess about the defender's limits. In other words: The offender will not know what the defender will choose but he knows quite well which strategies the defender cannot choose. Rational offenders will take this into consideration so that some kind of endogenous vulnerability emerges. This problem cannot be tackled by improved decisions of the defender alone but rather by a society-wide agreement on higher budgets or higher thresholds of acceptance. Third, game-theory puts more strength on forward-looking-procedures instead of backward-looking, history-oriented heuristics. As we know from crime reduction, too adaptive defense strategies run the risk of just reacting to events and thus forcing defenders into the passive role of a tortoise-hare-trap. This can quickly lead to heavy loss of resources and to a significant damage in reputation as the defense appears bustling and ineffective at the same time. In summary, the complementation of conventional approaches by game-theoretic analysis allows for a strategic and dynamic stress-test on the assumptions and the system's parameters. We apply this methodology in the RIKOV project which is funded by the Federal Ministry of Education and Research. Here it provides the user with hints ('warnings') about potential blind spots in his defense system.

Core Science Team

Sascha Meng
Marcus Wiens
Frank Schultmann
 Institute for Industrial Production (IIP), KIT

Publications

Meng, S., Wiens, M., Schultmann, F. (2014): A game theoretic approach to assess adversarial risks, Risk Analysis IX, Vol. 47, 141-152.

Wiens, M., Hu, B., Schmitz, W., Meng, S., Pickl, S., Schultmann, F. (2014): Optimizing security vis-à-vis terrorist attacks: An application for public rail transport systems, in: Thoma et al. (ed.), 9th Future Security Research Conference – Proceedings, Fraunhofer VVS, 254-262.

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Stategische Abschreckung von Terroranschlägen

Unter adversen Risiken versteht man die Gefahr materieller und immaterieller Schäden, die auf die Aktivitäten von feindselig eingestellten Personen(gruppen) zurückgeführt werden können. Beispiele hierfür sind Cyberrisiken sowie Risiken durch Wirtschaftskriminalität und Terrorismus. Während konventionelle Ansätze zur Analyse und Behebung dieser Risiken primär auf statistische Verfahren sowie auf Entscheidungsregeln unter Ungewissheit zurückgreifen, sind strategische Ansätze in diesem Bereich nach wie vor unterrepräsentiert. Das Forschungsprojekt integriert spieltheoretische Modellierung in den konventionellen Ansatz und untersucht das Zusammenspiel beider Methoden im Hinblick auf einen effektiven Schutz kritischer Infrastrukturen. Ein Anwendungsbeispiel liefert das vom BMBF geförderte Projekt RIKOV.

DSM CIP: The SEAK Project, Decision Support for Managing Disruptions in Food Supply Chains – Continuation from 2013

Andreas Motzke

Introduction

The SEAK project is part of the topic "Securing Food and Food Supply Chains" of the German security research programme, initiated and financed by the Federal Ministry of Education and Research (BMBF). Project partners are the Karlsruhe Institute of Technology (KIT), the Technical University of Darmstadt, and the 4flow AG. The project started on January 1, 2013 and is projected to end on December 31, 2015.

Nowadays, food supply chains (FSCs) are optimised systems that are operated on high performance levels. This makes them extremely time and cost effective, but also more vulnerable to disruptions caused by extreme events. Disrupted FSCs may lead to severe lack of food and drinking water. SEAK analyses causes and effects of such food shortages for an effective disaster management.

Aims/Objective

SEAK's major research aim is the improvement of the resilience and reliability of the food supply in Germany, in particular in the case of disturbances. A decision support framework is being developed which enables (i) an increased understanding and transparency of the food supply in Germany, (ii) the analysis of scenarios implying disruptions of FSCs, and (iii) an improved crisis and risk management. For this, logistical and transport simulation models, scenario techniques, and decision support methods are combined.

Project Status

SEAK focuses on three relevant threat scenarios which may lead to a food shortage or a FSC disruption: (i) a drop out of manpower, (ii) a heat wave, and (iii) a failure of the IT system. The selected scenarios in particular operate as cases for the proposed decision support framework by describing consequences within the supply networks, implications for the food supply, and the information needs of the actors involved. In 2014, additional experts –now 30 in total since 2013– from the private sector (e.g. food logistics companies) and from public authorities (e.g. federal state agencies) were interviewed to obtain information related to food supply shortages (scenario relevant aspects, decision-makers in charge, distribution of responsibilities, etc.). In particular, possible countermeasures and information needs of the key players involved ("Landkreise und kreisfreie Städte", "Regierungsbezirke", "Bundesländer", "Bund", private sector) were identified during an expert workshop ("Notfallplanung für Lebensmittelengpässe") at KIT with more than 25 representatives from public authorities of different administrative levels from Baden-Württemberg and one from the Federal Office for Agriculture and Food (BLE). The workshop evaluation is still ongoing. Based on results from this and one further internal workshop, a catalogue with possible countermeasures –dependent on the three scenarios– is being assembled for public authorities. Another important finding from the expert workshop was that local authorities are in charge of managing food shortages and FSC disruptions within their area of responsibility,
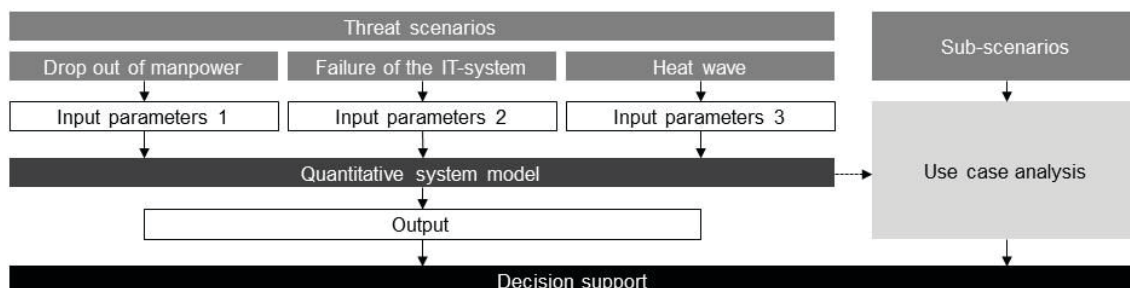

Fig. 1: Illustration of the coupling between the project parts "scenario construction", "quantitative system modelling", and "decision support".

while food distribution via FSCs is organised supra-regionally (partly even supra-nationally). Hence, a supra-regional instance or instrument to coordinate activities by the authorities may be necessary. This challenge needs to be resolved for a successful and efficient disaster management.
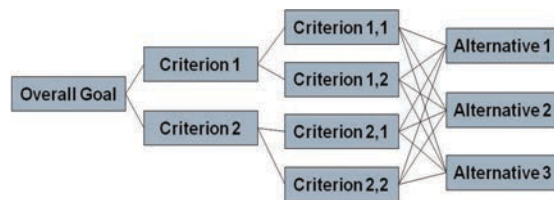

Fig. 2: Attribute tree.

Since 2014, we have been working on the three threat scenarios described above in two ways (see Fig. 1). Firstly, we use them to investigate the overall quantitative system under disruptions or states of failure. The objective is to observe how the system behaves when various input parameters are changed according to the scenario conditions. Therefore, impact factors were extracted for each scenario. They are coupled with the quantitative system in order to ensure their compliance with the input parameters of the system. Secondly, we developed various sub-scenarios (within the three threat scenarios). The sub-scenarios specify concrete decision problems that may arise in companies and authorities. This twofold usage of scenarios –from a holistic and from specific perspectives – offers two benefits: (i) the (overall) quantitative system is considered under several states of failures so as to understand how robustly and resiliently the overall FSC network reacts to disturbances and (ii) the definition of sub-scenarios allows the investigation of independent use cases to demonstrate the applicability of decision support methods.

Outlook

The second year of the SEAK project again illustrates the great synergies between the CEDIM institutes involved in the field of critical infrastructure protection (CIP). In SEAK's upcoming research, a problem oriented concept for a decision support framework will be developed based on the results obtained so far. One realisation could be a "how-to" guideline or manual for decision-makers. A more methodical, quantitative approach is e.g. to apply multi-criteria decision analysis (MCDA) such as the multi-attribute value theory (MAVT) or the

analytic hierarchy process (AHP). figure 2 illustrates the problem structuring by a general attribute tree. The "overall goal" is the securing of food supply. The task is to fill the tree by concrete "criteria" (= "indicators") and "alternatives" (= "countermeasures") depending on the (sub-) scenario under investigation, i.e. the respective outcome of the system modelling (see Fig. 1) and additional information if required. Generic criteria are e.g. costs and supply service level; weights of criteria are gained by e.g. expert evaluation. Possible alternatives for public authorities are provided by the catalogue resulting from the two workshops (see above). Finally, the resulting decision support will be tested and validated via a table-top exercise.

Core Science Team

Andreas Motzke
Thomas Münzberg
Wolfgang Raskob
Tim Müller
Evgenia Deines
Lijun Lin
Stella Möhrle
Stefan Wandler
 *Institute for Nuclear and Energy Technologies
 (IKET), KIT*

Frank Schätter
Mariana Bartsch
Marcus Wiens
Frank Schultmann
 Institute for Industrial Production (IIP), KIT

Tilman Matteis
Kay Mitusch
 Institute of Economics (ECON), KIT

Publications

Motzke, A.; Balster, A.; Hansen, O.; Herrmannsdörfer, M.; Schätter, F.; Friedrich, H.; Raskob, W.; Wiens, M.; Schultmann, F. (2014): The SEAK Project: Decision Support for Managing Disruptions in Food Supply Chains. In: Proceedings of the 9th Future Security, Security Research Conference, Berlin, September 16-18, 2014. Thoma, K.; Häring, I.; Leismann, T. (Eds.), Stuttgart: Fraunhofer Verlag, 2014, pp. 578-581, ISBN 978-3-8396-0778-7.

Münzberg, T.; Berbner, U.; Comes, T.; Friedrich, H.; Gross, W.; Pfohl, H.-C.; Schultmann, F. (2013): Decision Support for Critical Infrastructure Disruptions: An Integrated Approach to Secure Food Supply. In: Proceedings of the 10th International Conference on Information Systems for Crisis Response and Management (ISCRAM 2013), Baden-Baden, Germany, May 2013. Comes, T.; Fiedrich, F.; Fortier, S.; Geldermann, J.; Müller, T. (Eds.), pp. 312-316, ISBN 978-3-923704-80-4.

SEAK Projekt: Entscheidungsunterstützung zur Bewältigung von Versorgungsengpässen - Fortsetzung von 2013

Das im Rahmen des Nationalen Sicherheitsforschungsprogramms 2012-2017 vom Bundesministerium für Bildung und Forschung (BMBF) geförderte Projekt SEAK („Entscheidungsunterstützung zur Bewältigung von Versorgungsengpässen") beschäftigt sich mit dem Risiko- und Krisenmanagement von Behörden und Unternehmen bei Lebensmittelversorgungsengpässen in Deutschland. Dazu analysiert SEAK drei Szenarien, die zu Ausfällen und Störungen in Lebensmittelwarenketten führen können: (i) Arbeitskräfteausfall, (ii) Hitzewelle und (iii) IT-Ausfall. Eine szenariobasierte Entscheidungsunterstützung wird sowohl ganzheitlich als auch subszenario-spezifisch („narrative Fallstudien") entworfen (vgl. Abb. 1). Zum Beispiel wird ein ganzheitlicher Ansatz für Behörden verfolgt, bei dem eine Datenbank mit Standorten von Kapazitäten (z.B. Lebensmittel-Lagern, LKWs) und mit multikriteriell abgeschätzten Vulnerabilitäten (z.B. der 402 Landkreise und kreisfreien Städte) zusammen mit einem geeigneten Maßnahmenkatalog den Ausgangspunkt der Entscheidungsunterstützung bildet. In der Fallstudie „Arbeitskräfteausfall durch Pandemie – Filialschließungen in Berlin" wird z.B. eine subszenario-spezifische Entscheidungsunterstützung insbes. für Unternehmen entwickelt. Weiteres zu SEAK unter www.seak-projekt.de.

Business Continuity Management Against Food Supply Chain Disruptions

Frank Schätter, Marcus Wiens, Frank Schultmann

Introduction

Widespread research articles focus on decision-making in the immediate aftermath of hazardous events which affect a society and its logistical structures. Humanitarian logistics in particular is a prominent domain in this regard where the objective is to replace such affected structures temporarily. These approaches focus on situations where pre-existing logistical structures are severely disrupted and decision-makers such as governments, military, aid agencies, donors, non-governmental organizations and companies require decision support in order to implement robust logistical compensation structures that additionally hedge against various conditions of the uncertain decision situation. In turn, our approach complements the research on logistic resilience and business interruptions. Here pre-existing logistical structures have to be secured against the risk of sudden breakdowns in critical parts of the transport infrastructure.

Objectives

KIT-IIP works on a decision support methodology that concentrates on a decision situation where business continuity management is required to keep alive the functioning of threatened logistical structures due to a hazardous event. Decision-makers are companies themselves as operators of these logistical structures, particularly those whose businesses refer to the critical infrastructure sectors of food, water, health care, and energy. KIT-IIP cooperates with the SEAK project partner 4flow GmbH to develop a case study that applies the decision support methodology for business continuity management. A case study is developed dealing with a flu epidemic scenario in Berlin that triggers a high ratio of staff absence in a food retail company.

Project status and outlook

The SEAK project develops decision support concepts to prevent a hazard-affected society from possible food shortages due to food supply chain disruptions. In the course of the project heat waves, blackouts of the IT-system and staff absence have been mentioned by experts as primary risks for food shortages due to business interruptions. Based on these categories, the SEAK project consortium has defined nine threat scenarios indicating the possibility of food shortages due to, inter alia, disruptions of transport and production chains or destructions of inventory. For each threat scenario, a narrative description of the underlying decision situation has been formulated as a basis on which to develop and test innovative decision support concepts. The considered case study focuses on the decision problem of a retailer who is confronted with the problem of staff absence in a sales district. The inherent restrictions are firstly the ratio of available staff and secondly the uncertain evolution of local demands. The decision-makers are located at the management level of the food retailing company that supervises staff reallocations and has the competence to close stores in cases of necessity. To process the decision problem of staff distribution, an optimization model has been implemented where the optimal solution (distribution of available staff) depends on different demand distributions, highlighting demand shifts of the population. Each demand distribution is denoted as a scenario specification: the overall aggregation of these solutions across all scenarios leads to a set of alternatives that can be taken as actions to solve the decision problem. Testing the objective function of each alternative under all scenario specifications within the optimization model provides the basis to explore the robustness of each alternative to uncertain conditions. The application of the optimization model is work-in-progress; the conception of the case study has been submitted to the Humanitarian Technology Conference in 2015.

Core Science Team

Frank Schätter
Mariana Bartsch
Marcus Wiens
Frank Schultmann
 Institute for Industrial Production (IIP), KIT

Andreas Motzke
Thomas Münzberg
Wolfgang Raskob
 Insitute for Nuclear and Energy Technologies (IKET), KIT

Tilman Matteis
Kay Mitusch
 Institute of Economics (ECON), KIT

Wiederaufbau des Handelswesens zur Bewältigung von Versorgungsengpässen

Im Rahmen des Forschungsprojektes SEAK (Entscheidungsunterstützung zur Bewältigung von Versorgungsengpässen) untersucht das KIT-IIP gemeinsam mit dem Projektpartner 4flow GmbH die Auswirkungen eines Arbeitskräfteausfalls auf die Unternehmensabläufe eines Lebensmittelhändlers in Berlin. Aufgrund einer Grippewelle ist das Unternehmen dazu gezwungen, verfügbare Arbeitskräfte temporär umzudisponieren, um die Versorgung der Bevölkerung aufrecht zu erhalten. Die Projektpartner entwickeln ein Optimiermodell zur Allokation der Arbeitskräfte. Durch das gezielte Testen von unterschiedlichen Handlungsalternativen unter verschiedenen Nachfrageverteilungen in der Bevölkerung wird eine robuste Handlungsempfehlung identifiziert.

DSM CIP: Modeling and Simulation of Critical Infrastructures Using an Agent-Based Approach
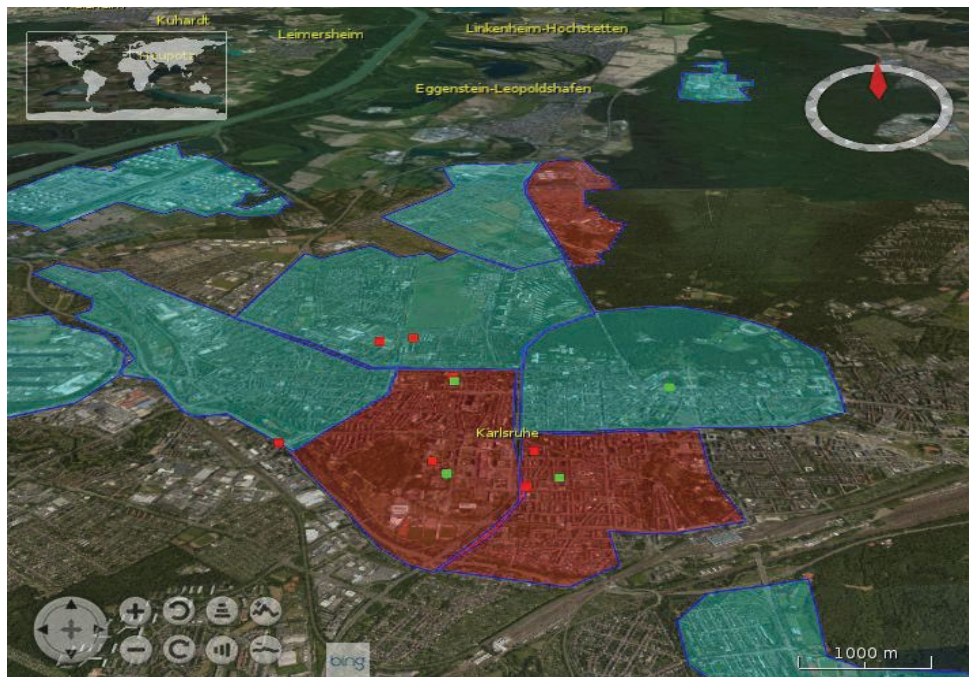
Evgenia Deines, Stefan Wandler

Fig. 1: Power Blackout Propagation, Karlsruhe Areas.

Introduction

In order to simulate power outages and their impact on Critical Infrastructures (CIs), we are using the agent-based modeling (ABM) approach – a flexible computer-aided method. The agents are autonomous and independent from other operating units. They have the ability to decide which action they take either to react to actions of other agents or to new conditions within their environment.

Aims/Objective

The objectives of the work are the study of CI behavior during power outages and investigate measures to optimize measures supporting decision-making.

Project status

To represent different CIs and their interdependencies, a relational model is being developed focusing on healthcare and water supply infrastructure. The ABM model represents CI elements as agents whose properties are stored in a database. The ABM framework is coupled to a database which allows storing and reading information related to particular simulations. It is further coupled to a Geographical Information System (GIS) allowing the visualisation of the simulation for particular geographical locations.

To consider the practical applicability of our approach, we decided together with our project partners DLR and the research centre Jülich, that the city of Karlsruhe will be our test case. Consequently, we have started to collect data concerning different elements of healthcare and water supply infrastructure in Karlsruhe. The data collection comprises characteristics and key parameter of the water supply chain and health care facilities such as hospitals, mental hospitals, dialysis practices, other smaller hospitals, and care facilities. Further to this, we are collecting potential management measures related to the above mentioned infrastructures: other options are those related to the operator and civil protection authority.

In October 2014, we participated in the organisation of the workshop "emergency planning for bottlenecks in food distribution and black-

outs". Day two of the workshop focused on representatives of civil protection authorities and health offices in Baden-Württemberg. The aim of this workshop was to provide information for building emergency plans, to identify vulnerabilities in crisis management, and to evolve and assess concrete measures for the perpetuation of health care during a blackout. As part of the workshop, we developed a questionnaire that was mainly related to decision making, e.g. how the participants would react in different crisis situations.

Outlook

The ABM model will be enhanced by adding further CI components and implementing their behaviors. For example, it is planned to integrate fuel supply or a model of an airport, in cooperation with our project partner DLR. Various scenarios, including decision-making structures and measures, will be simulated, taking into account also the increased use of renewable energy. The simulation results will be analyzed and the appropriate strategies to mitigate the consequences to the CI and the population during power blackouts will be tested.

Core Science Team

Evgenia Deines
Stefan Wandler
Wolfgang Raskob
Tim Müller
Thomas Münzberg
Stella Möhrle
Lijun Lin
Andreas Motzke
 *Institute for Nuclear and Energy Technologies
 (IKET), KIT*

Modelierung und Simulation von kritischen Infrastrukturen unter Nutzung eines agentenbasierten Ansatzes

Für die Simulation von Stromausfällen und deren Auswirkungen benutzen wir einen agentenbasierten Ansatz. Damit möchten wir einerseits das Verhalten der kritischen Infrastrukturen während des Stromausfalls untersuchen, und zum anderen auch potentiell einsetzbare Maßnahmen im Rahmen einer Entscheidungsunterstützung optimieren.

Unsere Hauptuntersuchungsgebiete sind dabei das Gesundheitswesen und die Wasserversorgung. Die Eigenschaften der einzelnen Elemente werden in einer Datenbank abgelegt, die während der Simulation laufend aktualisiert wird. Für eine bessere Untersuchung und Beobachtung der Abläufe, wie zum Beispiel der Ausbreitung des Stromausfalls, ist das agentenbasierte Model an ein Geografisches Informationssystem (GIS) gekoppelt.

Realitätsnähe ist in diesem Projekt ein wichtiger Aspekt und deshalb haben wir uns mit den Projektpartnern DLR und dem Forschungszentrum Jülich auf Karlsruhe, als die zu simulierende Stadt, geeinigt. Die Datensammlung hat begonnen. Des Weiteren haben wir den Workshops „Notfallplanung für Lebensmittelengpässe und Stromausfälle" mit organisiert. Dieser richtete sich an die Vertreter der Katastrophenschutzbehörden und der Gesundheitsämter in Baden-Württemberg.

Das Agenten basierte Modell wird mit verschiedenen Maßnahmen, Strukturen zur Entscheidungsunterstützung und einer Vielzahl an Szenarien weiter entwickelt. Durch die Analyse der Simulationsergebnisse sollen dann geeignete Maßnahmenstrategien getestet und verbessert werden, um die Auswirkungen des Stromausfalls langfristig zu minimieren.

DSM CIP: Understanding Resilience, Spatial-Temporal Vulnerability Assessment – Continuation from 2013

Thomas Münzberg, Marcus Wiens, Frank Schultmann

Introduction

The disruption of Critical Infrastructures (CIs), which supply the population with vital services and products, can lead to severe situations that request advanced activities from disaster management authorities and CI providers. To support these activities, we focus on the development of vulnerability models which allow for the consideration of time-dependent and spatial impacts of CI disruptions. The project on decision support through vulnerability assessments is based on the example of a power outage that affects all kinds of CIs in all districts of a city.

Aims/Objective

The vulnerability model should support local disaster management authorities and CI providers with a more accurate forecast of the spatial-temporal impacts of a power outage as one example of a CI disruption. Often, the individual impacts on single infrastructures are well known. However, a comprehensive view of the functionality of CI sectors as well as a common picture of the time-dependent effects are missing. In addition, the effects of alternative business continuity measures on the overall resilience of a city should be determined based on the spatial-temporal vulnerabilities of its districts.

Project status

In our previous work on a general framework for the spatial vulnerability assessment, we used a static indicator-based approach to measure the impacts of a power outage. The results of the framework enable decision makers to compare individual vulnerabilities of districts by taking into account the locations of CIs. In particular, the selection of the most appropriate districts to conduct the load shedding procedure was facilitated. Due to such a procedure, some consumers are decoupled from the grid to ensure network stability in times of network imbalances.

In 2014, we built the scientific basis to elaborate this model including temporal considerations. For this purpose, we reviewed current research results that focused on temporal assessments of CI disruption impacts and on methodological approaches which expand indicator-based models taking into account time-dependent effects (Münzberg, Wiens, and Schultmann, 2014a). Based on this result, we concentrated our activities on the relevancies of CIs, the temporal impacts of coping capacities such as emergency power units with different sizes of fuel tanks, and day-time referenced dependencies of CIs on electricity.

Other aspects issued in 2014 were the different types and numbers of CIs in a city and its relevance in providing a population with vital services and products. In Germany, there is an official definition of the CI sectors and branches that is determined from a federal perspective. At the local level of a city, there is no common or official definition of CIs that represent a city system. Also missing is a clear overview of which CIs are most relevant in providing critical services and products and, hence, should have a higher priority in supplying CIs with electricity than others. To overcome this problem, we carried out an expert survey in three steps. In the first step, we tested a questionnaire in which a small number of experts with practical experience were asked to define a priority value for CIs. For this purpose, we defined a set of CIs which was derived from the official federal definition of CI sectors which present facilities at the local level. The survey was embedded in an invited talk to an expert audience of the Program at the German Annual Trade Fair for Fire Brigades, Fire Protection and Disaster Management (Münzberg, Wiens, Schultmann, 2014b). In addition, experts were asked to add missing CIs.

In the second step, the questionnaire was adjusted based on the findings from the first step. The new questionnaire was given to experts that participated in our workshop on 'disaster management planning for food shortages and power outages'. The experts were representatives from the local disaster management and health authorities of cities, districts, and regional governments in Baden-Württemberg which are in charge of disaster planning in their area of responsibility.

In a next step we considered different degrees of coping capacities of the CIs. To cope with a power outage, typically the CIs have emergency power units with fuel tanks of different sizes. These enable CI providers to delay the adverse effects and to ensure a continued business for a limited time. The more capacity is consumed, the less is the ability to cope with the abnormality and, hence, vulnerability increases. Based on the aggregation methodology from our previous work, it is possible to estimate district specific vulnerability profiles. These profiles display the increase vulnerability, taking into account the localization of CIs, their relevancies and their coping capacities. Decision-makers are able to conduct sensitivity analyses by changing the capacities and assessing the differences in the vulnerability profiles. This allows a comparison of the impact of different strategies and an assessment of district resiliencies. For this purpose, we developed a framework (Münzberg, Wiens, and Schultmann, 2014c). Methodologically, we used the results of temporal vulnerability analysis and predefined, time-depending protection target levels. This allows decision makers to assess how well alternative coping strategies perform and satisfy predefined goals.

Another issue in 2014 was the enhanced link to practitioners and end-user cooperation. Based on the outcome from the expert workshop, conducted in autumn 2014, we enhanced our end-user orientation and addressed several scientific issues to the practitioners. In addition, our approaches and model results were presented in several invited talks including the annual trade fair for fire brigades, fire protection and disaster management (Münzberg, Wiens and Schultmann, 2014), already mentioned above, and the PMR-Conference 2014 which is an international conference for professional mobile radio and control rooms (Münzberg, Wiens, and Schultmann, 2014d). In addition, we contributed peer-reviewed scientific papers to end-user orientated events such as the 62nd Annual Expert Meeting of the German Fire Protection Association (vfdb) (Münzberg, Wiens, and Schultmann, 2014e) and the 14th Forum on Disaster Preparedness of the German Committee for Disaster Reduction (DKKV) (Münzberg, Wiens, and Schultmann, 2014f).

Outlook

In 2015, we will analyze, compare, and verify the results of the various surveys. This will provide more insight in the decision-maker's perception of the relevancies of CIs on a local level. Another interesting field for research is to consider the varying dependence of the CI on electricity with time. The dependence of a CI on electricity changes over time according to the business undertaken during a day. We assume that the vulnerability of a CI is higher at a time of the day in which this dependency reaches the highest degree. To include this aspect, we will complement our research activities by including standardized load profiles that are usually applied in the load management of electricity grids.

This approach allows for an assessment of the performances of different coping strategies. The next step would be to systematically include this into disaster management planning. For this purpose, we will investigate several business continuity measures that could define different strategies.

Core Science Team

Thomas Münzberg
Stella Möhrle
Wolfgang Raskob
Tim Müller
Lijun Lin
Evgenia Deines
Stefan Wandler
Andreas Motzke
 Institute for Nuclear and Energy Technologies (IKET), KIT

Marcus Wiens
Frank Schultmann
 Institute for Industrial Production (IIP), KIT

Publications

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Verständnis von Belastbarkeit, zeitlich begrenzte Vulnerabilitätsanalysen - Fortsetzung von 2013

Kritische Infrastrukturen (KRITIS) versorgen die Bevölkerung mit lebenswichtigen Dienstleistungen und Gütern. Fallen sie aus, kann dies zu verheerenden Folgen führen. Um insbesondere die kommunalen Gefahrenabwehrbehörden als auch die KRITIS-Betreiber bei der Vorbereitung und Bewältigung von KRITIS-Ausfällen zu unterstützen, entwickeln wir zeit-räumliche Vulnerabilitätsanalysen. Das Ausgangsereignis ist dabei ein langanhaltender Stromausfall, dessen Wirkungen auf die verschiedenen KRITIS-Einrichtungen einer Kommune über die Ausfalldauer analysiert werden. Hierzu werden die Standorte und die vorgehaltenen Bewältigungskapazitäten wie Notstromaggregate verwendet, um infrastrukturspezifische Vulnerabilitätsverläufe abzubilden. Damit wird ein Verständnis ermöglicht, wie Stromausfälle über die Zeit bei einzelnen Einrichtungen zu einer Eskalation führen. Des Weiteren analysieren wir durch Expertenbefragungen die Bedeutung der einzelnen KRITIS-Einrichtungen für die Versorgung der Bevölkerung mit lebenswichtigen Dienstleistungen und Gütern. Hierdurch lassen sich die in einem Stadtteil oder in einer Gemeinde befindlichen KRITIS-Einrichtungen und ihre Eigenschaften zu Vulnerabilitätsprofilen aggregieren. Diese verdeutlichen den Verlauf der Vulnerabilität einzelner Regionen bei einem Stromausfall. Mit dieser dynamischen Darstellung lässt sich die Resilienz der einzelnen Regionen aber auch die Resilienz der gesamten Kommune ableiten und die Wirkungen verschiedener Bewältigungsstrategien vergleichbar machen.

Regional Climate Change and the Industry's Fragility – An Indicator-Based Approach

Hanns-Maximilian Schmidt, Karoline Fath, Marcus Wiens, Julian Stengel, Frank Schultmann

Introduction

The IPCC's "Fifth Assessment Report: Climate Change 2013" provides scientific evidence for the ongoing environmental changes that come along with climate change. Concerning our society and the industrial sector in particular, the efforts to mitigate or adapt to these incontrovertible challenges are subject to the decision-makers' risk assessment and their individual and collective risk perception. In order to support risk response and strategies for adaptation on the municipal level in Baden-Wurttemberg (BW), we designed an indicator-based approach that considers regional characteristics of climate change as well as the (regional) economic structure. Therefore, we combined high-resolution climate projections (A1b scenario) for BW provided by the Institute of Meteorology and Climate Research (IMK-TRO) at the KIT with economic indicators derived from the Federal Statistical Office and from input-output analysis for the specific region. The overall goal is to raise the awareness of the stakeholders concerning regional climate change.

The project KLIMOPASS is funded by the Ministry of the Environment, Climate Protection and the Energy Sector Baden-Wurttemberg and coordinated by the Landesanstalt für Umwelt, Messung und Naturschutz Baden-Württemberg (LUBW). Our sub-project was processed from October 2013 until July 2014.

Indicator Framework for the Stuttgart Metropolitan Area

The Stuttgart Metropolitan Area includes 480 communities in 20 rural districts with more than 5 million people living there . Within the urban areas, e.g. Stuttgart, Heilbronn, Tübingen, etc., are situated some highly specialized industries. In particular, automotive companies and their suppliers play an important role regarding the employment. As the IMK-TRO's data show, climate change is likely to affect this highly industrialized region. It forecasts a decrease in cold and frost days of more than 28 percent for the period from 2021 to 2050, whereas the number of hot days might rise to 96 percent. Days of high precipitation are also likely to increase by 21 percent compared to the reference period 1971 – 2000.

When it comes to the physical impacts of climate change and extreme weather events on

Table 1: Set of indicators (industry).

Category	Indicator	Description
Fixed Assets	Specific assets	Dependency on operating materials
Staff	Personnel intensity	Dependency on personnel
	Degree of staff specialization	Share of staff members with college degree
Infrastructure	Specific energy use	Energy consumption per revenue
	Dependency on energy	Decrease in productivity per loss
	Specific water use	Water use per revenue
	Dependency on water	Decrease in productivity per loss
	Use of transportation	Diversification of transportation modes used
Supply Chain	Key Sectors	Sector's importance for the supply chain
	Specific material cost	Measuring specialization of manufacturing processes

industry, there are four vulnerable assets to be observed: fixed assets and equipment (machinery, buildings), staff working in administration or production, infrastructure (transportation services) and economic interrelations along the supply chain that might lead to cascading effects. Within these categories we identified 10 economic indicators. Most of them can easily be drawn from official economic data whereas the factors concerning the dependency on energy and water are deducted from literature. As there are no data available for BW, the indicators state the nation-wide average for each of the 16 industrial sectors. Moreover, the indicator "Key Sector", which indicates that a sector plays an important role as a supplier and purchaser of goods at the same time, is drawn from the regionalized input-output table for BW that we performed as suggested by Flegg & Thomo (2011). However, by using the entries of an online address database for companies in Germany we were able to assign the industries' vulnerability indices (as a weighted sum of all indicators) to the communities. Obviously, our indicator composition focuses on the industry's fragility. Any factors concerning resilience of the given systems are explicitly excluded as we did not want to underestimate certain aspects. The indicators were normalized on a scale from 0 to 1 and equally weighted. All of them and their short descriptions are listed in table 1.

The results clearly show that the industries suffer from different circumstances that drive their fragility towards climate change impacts. As figure 1 indicates, the fragility drivers seem to differ between the sectors according to the chosen indicators. While the chemical industry is highly driven by its dependency on water and energy and its importance for other industries, the automobile industry, for example, is quite vulnerable due to its high degree of specialized staff working in the facilities. The energy and water supply sector, however, shows a strong dependency on its static and highly exposed infrastructure and fixed assets.

Additionally, we defined climatic indicators for the area on a municipal level that were derived from changes in the climate projections over time. The high-resolution climate data (raster width: 7 km) provided by the IMK-TRO includes the following attributes for the time span from 2021 to 2050:

- Number of ice and frost days
- Number of hot days
- Number of days with high precipitation
- Maximal wind velocities

These indicators were used to define scenarios and were added to the sectorial results in order to raise the resolution of the local analysis. For each community we calculated the average change of the indicator between the two periods (1971 – 2000 and 2021 – 2050). Moreover, we added some general information on the specific regions including population densities, sum of industrial buildings etc. in order to introduce a certain weighting regarding the socio-economic attributes of the communities. This
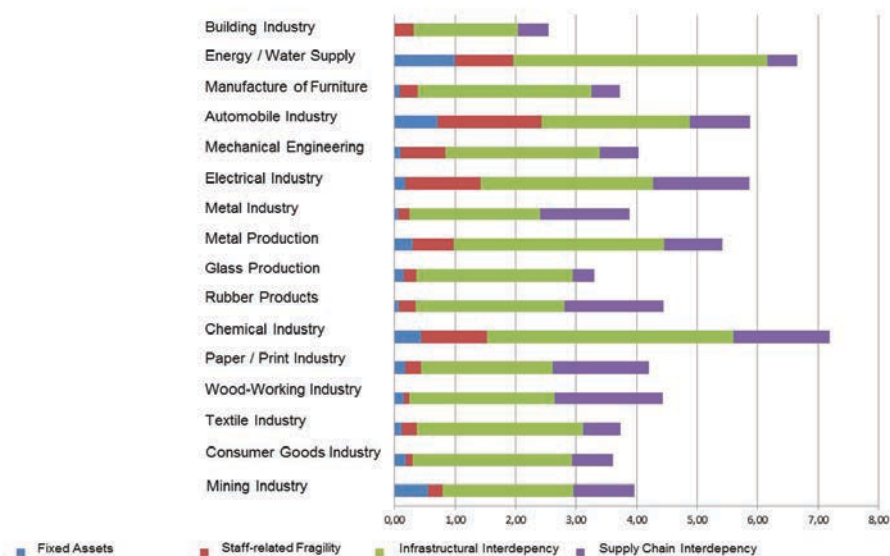

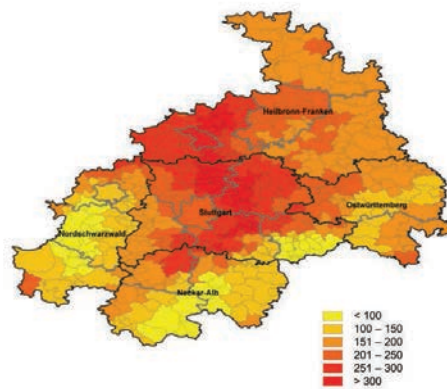**Fig. 1**: Indicator values of 16 industries in Baden-Wurttemberg.

procedure was recommended at a stakeholder workshop that we conducted in May 2013.

Results and Outlook

The high-resolution data we calculated from general, climatic and industrial indicators can easily be visualized by geographical information systems. These maps give a detailed overview on the industry's fragility on a community level. They allow stakeholders like urban planners or companies to become aware of the projected circumstances within their region and might support climate change policies and knowledge transfer. figure 2 gives an example of what these maps look like.

In our case study, including 480 communities, we demonstrate that the indicator-based approach is an easily comprehensible and valid tool for quick identification and analysis of hot spots of climate change impacts in highly industrialized areas. Moreover, the indicator composition and the widely available input data used allow for an application of this method to other urban regions throughout Germany and Europe. However, for developing countries one needs to define new indicators that can be adjusted to the data available. Therefore, we are looking forward to further improvement of the methodology and further case studies in other regularly affected regions.
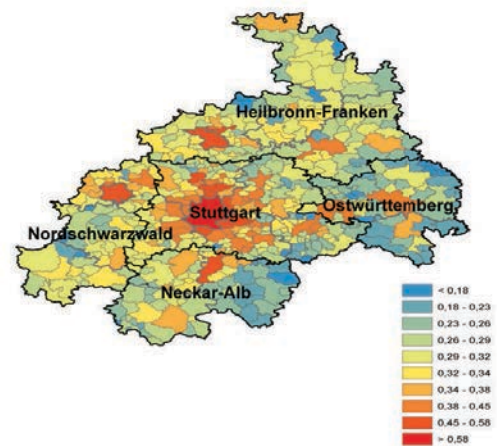

Fig. 2: Hot days projection (left) and the Fragility Index (right).

Core Science Team

Hanns-Maximilian Schmidt
Marcus Wiens
Frank Schultmann
 Institute for Industrial Production (IIP), KIT

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Regionaler Klimawandel und die Fragilität der Industrie - Eine Indikatorbasierte Annäherung

In der Industrie können sich schwankende Wetterparameter und die Häufung von Extremwetterereignissen im Unternehmensergebnis widerspiegeln und so die Wirtschaftlichkeit einer Anlage oder eines Betriebes nachhaltig stören. Zur Abschätzung der industriellen Vulnerabilität in der Metropolregion Stuttgart wurde eine indikatorbasierte Analyse entwickelt und durchgeführt, die es erlaubt, regionsspezifische Merkmale, wie die Bevölkerungsdichte oder den Gebäudebestand, die regionalen Projektionen des Klimas und die industriespezifischen Eigenschaften, wie die Abhängigkeit von Elektrizität und Wasser, auf Gemeindeebene zu kombinieren und mittels geographischer Informationssysteme zu visualisieren.

Hierfür wurden unterschiedliche Szenarios und Gewichtungen eingeführt, um die Verwundbarkeit der regionalen Industrie hinsichtlich einer steigenden Anzahl an heißen und trockenen Tagen, Eis- und Frosttagen sowie der sich verändernden maximalen Windgeschwindigkeiten und Niederschlagsintensitäten zu messen und ihnen vergleichbare Werte zuzuordnen. Die Ergebnisse zeigen, dass durch die allgemein hohen Anforderungen der im Land weit verbreiteten und im Raum Stuttgart besonders geballten Automobil- und Elektroindustrie sowie durch die besondere Verwundbarkeit der Wasser- und Energieversorgung einzelne Regionen besonders vom Klimawandel beeinträchtigt werden könnten. Energie-, wasser- und personalintensive Unternehmen werden demnach die Auswirkungen am deutlichsten zu spüren bekommen. Auf Gemeindeebene bedeutet dies auch, dass gerade Ballungsräume mit zunehmender Spezialisierung betroffen sein werden. Im betrachteten Raum weisen die Stadt Stuttgart und ihr unmittelbares Umland eine besondere Vulnerabilität gegenüber dem Klimawandel auf, die sich aus der Aggregation aller Vulnerabilitätsindikatoren ergibt.

Global Earthquake Model

GEM Testing & Evaluation Center

Danijel Schorlemmer, Jochen Zschau

Introduction

The Global Earthquake Model (GEM) is developing the first homogeneous hazard and risk model for the entire globe. Such a model is assembled from data, known physical properties, statistical descriptions of physical phenomena, and assumptions – often called expert opinion. Over the past decade, independent testing of seismic rate models became a standard through the Collaboratory for the Study of Earthquake Predictability (CSEP) and is further emphasized by the L'Aquila earthquake and its legal aftermath. The Testing & Evaluation component of GEM is building on these developments and taking the role of an independent evaluator for the most important parts of GEM by operating a dedicated Testing Center at GFZ.

Aims/Objective

The T&E component works together with the model builders to make GEM and its part as testable as possible. It provides tools and software systems for retrospective testing to help improving the model during its development stage, it tests pseudo-prospectively and prospectively many components of GEM, and it works on testing high-impact assumptions of GEM. The following components have been identified as primary targets for testing:

1. Seismicity rate models
2. Develop a prototype testing chain for the OpenQuake system of GEM
3. Implementing a ground-motion prediction testing center to test intensity and ground-motion prediction equations
4. Developing prototype tests for hazard model testing
5. Collaborating with the Global Consequences Database component to characterize the current and future dataset for testing risk models
6. Setting up a testable hypothesis for testing M_{max}

Project status

Seismicity Rate Testing

We finished the work on seismicity rate testing for the region of California. Investigating a suite of 3-month forecasting models revealed useful strategies for aftershock sequence forecasting and decision support for an aftershock hazard modeler. The test of the Uniform California Earthquake Rupture forecast (UCERF2) and the forecast of the National Seismic Hazard Mapping Project (NSHMP) showed good performance when compared to the suite of forecasts from the Regional Earthquake Likelihood Models (RELM) project. One RELM model showed consistently the best performance. As a consequence, the main features of that winning model are now becoming part of UCERF and NSHMP.

We have investigated the possibilities of improving forecasts by creating ensemble models. The focus of this study was on multiplicative hybrids using the RELM models as the input models. We found that many two-model or three-model hybrids have an appreciable information gain per earthquake relative to the best individual model. Larger information gains are obtained when the contributing models involve markedly different concepts or data.

For the upcoming tests of the Global Earthquake Activity Rates (GEAR) model, we have prepared the forecast definition and have been working on the implementation for this experiment.

Ground Motion Testing

We have investigated the Euclidean Distance-Based Ranking (EDR) method for selecting and ranking ground-motion prediction equations (GMPEs) by Özkan Kale and Sinan Akkar. We found that the presented score is not proper and have documented this fact in a comment on the original paper.

Hazard Testing

Many researchers have worked on site-specific testing of hazard estimates and several scores and strategies for result interpretation were published. We have investigated the power of such statistical tests with sobering results. Under best available conditions (longest datasets) one still needs to observe a seven times higher hazard to reject the modeled hazard with a comparatively low power of 90%. The results of this work clearly demands that hazard estimates be tested on a large collection of sites.

To move into testing hazard models, we have undertaken a case study and tested the suite of National Seismic Hazard Mapping Project (NSHMP) models of the US. Unlike previous studies by others, we have used three different datasets as observations: Crowd-sourced intensity reports ("Did You Feel It?" by the USGS), ShakeMaps, and strong-motion recordings. We were able to show that the US hazard models are improving over time. This is the first rigorous, quantitative, and comparative test of US hazard models. We were also able to show that all three datasets deliver essentially the same result, allowing us in the future to test hazard models in regions for which strong-motion data are not available and only derived data like ShakeMaps or intensity reports exist.

Outlook

The first phase of GEM has ended. However, we are looking forward to the second phase in which we will work on automating the testing processes and improving decision support capabilities. Together with the Global Dynamic Exposure project, we are working towards quantitative risk testing. Finally, we aim to open our infrastructure for external experiments.

Core Science Team

Thomas Beutin
Sum Mak
Danijel Schorlemmer
 GFZ Potsdam. Section 2.1

Publications

Papers

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GEM Testing and Evaluation Center

Das Global Earthquake Model (GEM) entwickelt das erste weltweit homogene Gefährdungs- und Risikomodel für Erdbeben. Innerhalb GEMs arbeitet das Testing & Evaluation Projekt daran, die verschiedenen Bestandteile dieses Models zu testen. Zu den wichtigsten zählen die Erdbebenratenmodelle, Modelle zur

Vorhersage der durch Erdbeben hervorgerufenen Bodenbewegungen, die resultierenden Gefährdungs- und Risikomodelle und ausgewählte weitreichende Annahmen, die in den Modellen verwendet werden. Dazu gehört das Konzept der maximalen Magnitude von Beben in bestimmten Gebieten. Alle Tests werden im GEM Testing Center am GFZ Potsdam durchgeführt.

Social Vulnerability and Integrated Risk Project in GEM

Bijan Khazai, James Daniell, Christopher Power, Susan Brink, Johannes Anhorn, Christopher Burton
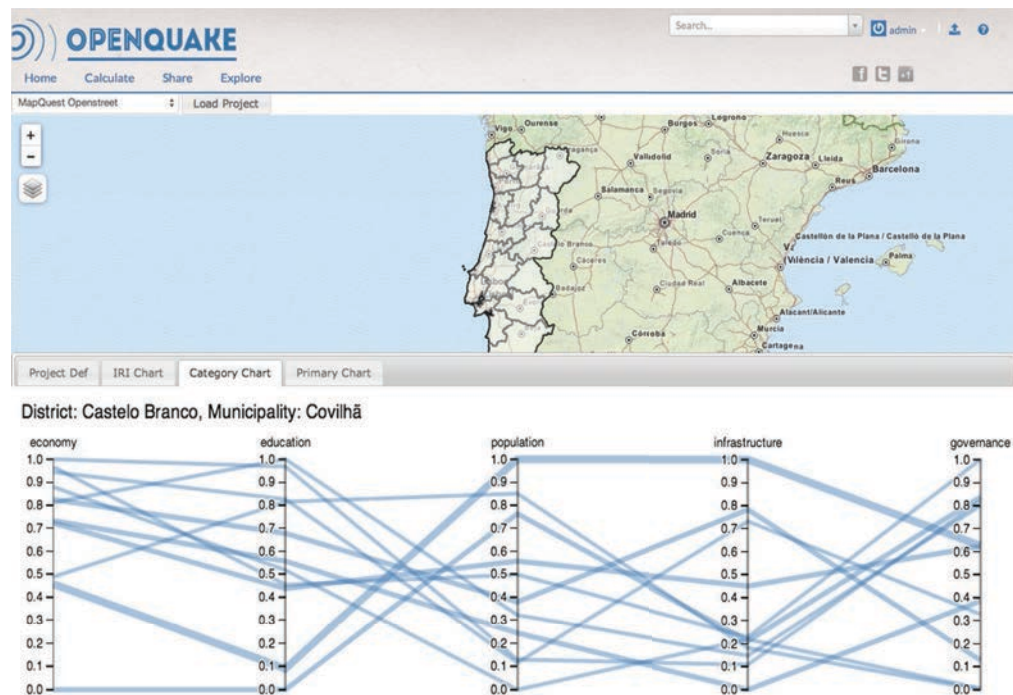

Fig. 1: Snapshot of the visualization of the Integrated Risk Modelling Toolkit on the OpenQuake platform.

Introduction

At the core of the Global Earthquake Model (GEM) is the development of state-of-the-art modeling capabilities that can be used worldwide for the assessment and communication of seismic risk. The socio-economic vulnerability and integrated risk working group is working on the implementation of methods, metrics, and tools for holistic evaluation of earthquake risk, such as indexes for social vulnerability, resilience, and indirect loss. The two year Socio-economic Vulnerability and Integrated Risk Project began in September 2012 as a collaboration between CEDIM (KIT) and the GEM Foundation and the Willis Research Network (WRN). The project is led by Bijan Khazai from KIT and is a part of the Social Vulnerability and Integrated Risk Program of GEM coordinated by Christopher Burton.

Aims/Objective

The goal of the project is to integrate Open Source software tools, spatially-enabled and open databases, and indicators and indices with GEM's on-going activities of hazard and physical risk to address the differential susceptibility of populations to the adverse impacts of earthquake events in a holistic manner that accounts for both physical risk and the social circumstances at a given place.

Project status

The CEDIM Socio-economic Vulnerability and Integrated Risk Project was completed in December 2014 and the results are to be presented at the 2015 GEM Reveal. One of the key outcomes of the project has been the development of multiple comprehensive, spatially enabled databases for building indicators and indices of social and economic vulnerability that are integrated with the Open Quake Platform (Power et al., 2015). These are scaled at the national level for the globe, sub-national level for the Asia-Pacific region. Another major accomplishment has been the design and development of an Integrated Risk Modelling Toolkit in collaboration with the GEM Modelling Facility (Khazai et al., 2014). The Toolkit has recently been released as an extension

for Quantum GIS and allows users to access the Global and Sub-National databases on the Open Quake platform for the development of social, economic, and integrated risk indices (Fig. 1). Moreover, the software tool will allow users to manipulate and interact with all of the data, which may be inputs to both physical earthquake risk and social vulnerability models.

To demonstrate the potential of the databases and the tool, two use cases were developed by the Social Vulnerability and Integrated Risk working group. One of these is an indicator framework for quantifying the potential for indirect economic losses from earthquakes developed by James Daniell (Daniell et al., 2015). The framework is based on a comprehensive review of existing literature and methods associated with indirect losses, and utilizes indicators from the Global and Sub-national databases to operationalize a ranking of indirect loss potential world-wide and for Prefectures in Japan. A second framework and index was produced by Susan Brink for population displacement following disasters which provides a simple way of representing the multiple aspects of population displacement and the factors that aggravate them using a comprehensive review of the existing literature (Brink et al., 2015). The Sub-national database in GEM has been used for operationalizing the framework for es-
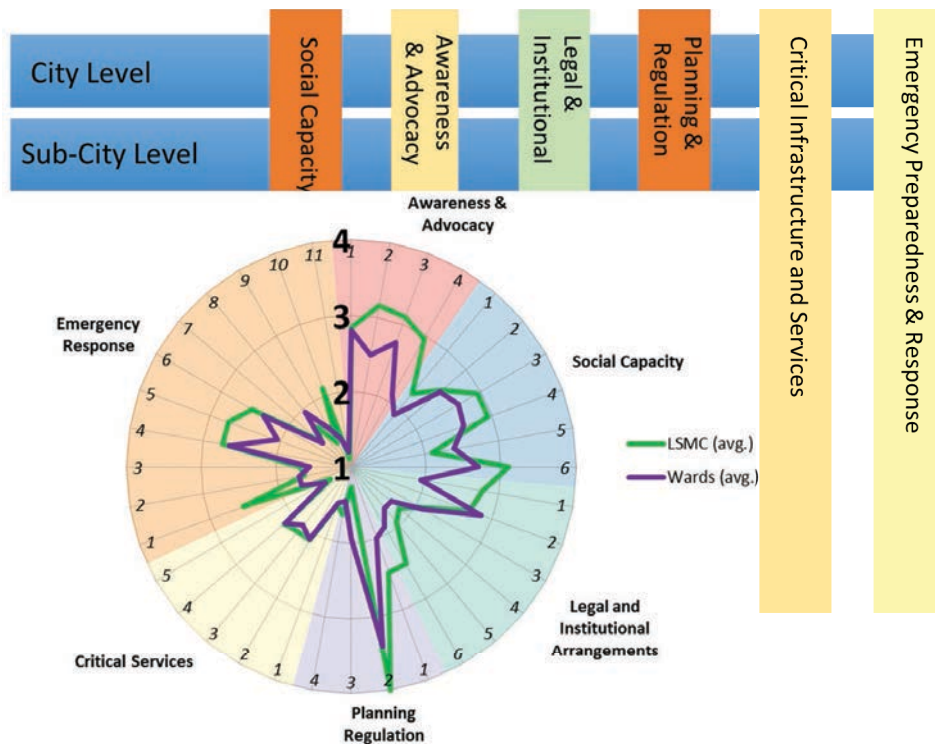

Fig 2: Six dimensions of the Multi-level Risk and Resilience Scorecard with a spider chart showing implementation at both the Municipal and Ward levels.

timating vulnerability to disaster displacement of Prefectures in Japan.

Besides the development of quantitative indicators for estimating social and economic vulnerability that can be computed from publically available databases, a key thrust in the project has been an alternative approach focusing on qualitative information for the production of relevant indicators and targets representative of key functional and organizational areas for urban resilience, based on a participatory assessment process with local government officials. The result has been development of a Multi-level Risk and Resilience Scorecard in collaboration with GEM, the South Asia Institute (SAI) of Heidelberg University and the National Society for Earthquake Technology (NSET) (Khazai, et al., 2014). The Scorecard was implemented as a self-evaluation tool with both Ward-level and Municipal representatives from Lalitpur in March 2014 and empowered these stakeholders to quantitatively assess resilience parameters based on their experiential knowledge and perception of the city's disaster resilience along six dimensions (Fig. 2).

To extend and deepen CEDIM's collaboration with GEM and build on the existing experiences and capacities developed, a project concept has been discussed with GEM and a proposal submitted to the GEM Governing Board. In particular, the proposed project aims to go beyond result-oriented monitoring and evaluation tools by developing, and testing under various contexts, a Participatory Multi-level Resilience Assessment and Management Framework, Handbook and Scorecard Tool.

Core Science Team

Bijan Khazai
James E. Daniell
Christopher Power
Susan Brink
 Geophysical Institute, KIT

Johannes Anhorn
 South Asia Institute, Heidelberg University

Christopher Burton
 GEM Foundation

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Soziale Verwundbarkeit und integriertes Risiko in GEM

Innerhalb des Global Earthquake Models (GEM) ist die Entwicklung hochmoderner Modellierungsmöglichkeiten ein grundlegender Bestandteil, um weltweit seismisches Risiko einzuschätzen und die Informationen weiter zu leiten. Das "Socio-economic Vulnerability and Integrated Risk Project" befasst sich in diesem Zusammenhang vor allem mit der Implementierung unterschiedlicher Methoden und Werkzeuge für eine ganzheitliche Ermittlung von Erbebenrisiken wie beispielsweise die Indizes für soziale Verletzlichkeit, Belastbarkeit sowie indirekte Verluste. Die Informationen hierzu wurden aus öffentlich zugänglichen Datenbanken bezogen. Zudem werden mit einem weiteren Ansatz qualitative Informationen gewonnen, um relevante Indikatoren bezüglich der Gebiete mit öffentlichen und repräsentativen Einrichtungen zu gewinnen. Die Ergebnisse wurden mit Hilfe einer Multi-Level-Risiko- und Belastbarkeits-Wertungsliste entwickelt, welche in einer Kollaboration von GEM, dem South Asia Institute der Universität Heidelberg und der National Society for Earthquake Technology (NSET) entstanden sind. Die Wertungsliste wurde bereits erfolgreich als ein Werkzeug zur eigenständigen Einschätzung in Lalitpur (Nepal) eingesetzt und ermöglichte die qualitative Ermittlung der Belastbarkeitsparameter, beruhend auf Erfahrungswerten aus vergangenen Ereignissen.

II. Strategic Partnerships

Earth System Knowledge Platform ESKP

Introduction

The "Earth System Knowledge Platform – ESKP" is part of the Helmholtz-Association's Portfolio process in the Research Field Earth and Environment. The eight centers in this field take part in the initiative that is jointly coordinated by Helmholtz Centre Potsdam GFZ, German Research Centre for Geosciences GFZ and Helmholtz Centre Geesthacht, Centre for Materials and Coastal Research HZG. The coordination office is located at GFZ. In cooperation with the participating Helmholtz centres, ESKP provides the latest research findings and news about ongoing events in the three focal areas (1) natural hazards, (2) climate change, and (3) transport of substances and pollutants. Thus, ESKP is an important partner for CEDIM in disseminating results of the Forensic Disaster Analysis to the media and the public and as such significantly increases the distribution of

Philippinen waren auf Taifun Hagupit besser vorbereitet

CEDIM-Wissenschaftler fassen den zeitlichen Verlauf und die Auswirkungen des Taifun Hagupit zusammen.

10. Dezember 2014 · Naturgefahren / Sturm
Karlsruher Institut für Technologie (KIT)

Fig. 1: Snapshot on www.eskp.de, December 2014. English Translation: Philippines better prepared for Typhoon Hagupit. CEDIM researchers summarize the evolution and the impact of the Typhoon Hagupit. Full article available at: http://www.eskp.de/philippinen-waren-auf-taifun-hagupit-besser-vorbereitet/

the results. 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.

Aims / Objective

ESKP communicates scientific results and knowledge on environmental processes, the Earth system, its dynamics and risks achieved in the eight Helmholtz Centers in a way that enables society to mitigate hazardous developments and react adequately to present and future environmental changes. By editing and providing knowledge in an appropriate way, ESKP aims to support the dialogue between science, politics, economy, education and the public. In each Helmholtz centre an ESKP staff member is established as a partner for scientists to ensure the knowledge transfer from the eight centers and its integration into ESKP,

Project status

The bilingual Helmholtz knowledge platform www.eskp.de was launched in May 2014. CEDIM researchers contributed in several ways to the platform and used it to disseminate research results.

In the case of CEDIM FDA Task Force activities, CEDIM provided the FDA reports with an additional summary to ESKP, making the CEDIM reports accessible for a wider audience than may be reached via the CEDIM website alone. When the platform was still under construction, CEDIM provided the first FDA reports to ESKP after Typhoon Haiyan in November 2013 with a focus on rapid loss assessments and rapid mapping of damage in the City of Tacloban. In the course of the year 2014, CEDIM researchers analyzed a number of events in short CEDIM summaries outside FDA activities and provided them to ESKP: other examples were the Typhoons Hagupit and Rammasun that hit the Philippines in December 2014 and in July 2014 respectively, the thunderstorms in North-Rhine-Westphalia, Germany, in July 2014, and the floods in Eastern Europe in May 2014. Reports on past events such as Hurricane Sandy

in 2012 and the floods in Germany 2013 were included retrospectively on the portal to foster collaboration and knowledge transfer in the topic natural hazards on www.eskp.de.

CEDIM researchers have complemented the reports on ongoing or recent events by short articles that explain basic knowledge on natural hazard processes such as hail, thunderstorms, tropical storms, or earthquakes, and on related topics such as storm hazard in Germany, risk assessment, early warning systems, and the relationship between urbanization and disasters.

In addition, the interactive CEDIM Risk Explorer is accessible via www.eskp.de.

Contributors

Bernhard Mühr
Michael Kunz
Susanna Mohr
Christoph Kottmeier
 KIT, Institute for Meteorology and Climate
 Research

Tina Kunz-Plapp
Bijan Khazai
Friedemann Wenzel
 KIT, Geophysical Institute,

Danijel Schorlemmer
Werner Trieselmann
Jochen Zschau
 GFZ, Section 2.1 Physics of Earthquakes and Volcanoes

Kai Schröter
Heidi Kreibich
Bruno Merz
 GFZ, Section 5.4 Hydrology

Doris Dransch
 GFZ, Section 1.5 Geoinformatics

Cooperation with Integrated Research on Disaster Risk (IRDR)

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). Having coined the term "forensic disaster investigations", the IRDR initiative identified forensic investigations of disasters (FORIN) as one of its key activities that "aims to uncover the root causes of the disasters through in-depth investigations that go beyond the typical reports and case studies conducted after disasters" and to "help build an understanding of how natural hazards do—or do not—become disasters." (IRDR Strategic plan 2013-2017, http://www.irdrinternational.org/wp-content/uploads/2013/04/IRDR-Strategic-Plan-2013-2017.pdf).

With its focus on near real-time disaster analysis to identify major risk drivers, CEDIM's research activity Forensic Disaster Analysis (FDA) is complementary to IRDR's more long-term analysis. An important aim of the cooperation with IRDR FORIN is to build the necessary links between the FDA's near real time analysis conducted by CEDIM and the IRDR's long term forensic disaster analysis program FORIN.

In 2014, two CEDIM researchers attended the 2nd IRDR Conference in June in Beijing, China and participated in the FORIN session. The session included an introduction to FORIN and two presentations covering FORIN investigations conducted by researchers in other institutions. In addition, the CEDIM researchers gave two presentations on research conducted by CEDIM. The first presentation summarized the CEDIM FDA project detailing methods and giving examples of the output of some FDA investigations. The second presentation discussed in detail one of the CEDIM FDA projects. Following these presentations there was a question and answer session during which participants discussed each individual project and the relationship between FDA and FORIN.

Cooperation with the Insurance Industry

Willis Research Network

The Willis Research Network (WRN), formed in 2006 by the global insurance broker Willis, is a network of more than 50 of the world's leading research institutions. It aims to provide an open forum for the advancement of the science of extreme events through close collaboration between universities, insurers, reinsurers, catastrophe modelling companies, government research institutions and non-governmental organizations. CEDIM still is the only German partner of the network since 2009. As a partner of the WRN, CEDIM staff gather experience in the cooperation with the insurance industry and has learned about their needs and research priorities. WRN cooperates with CEDIM by funding Willis fellows at the working groups "Atmospheric Risks" (IMK/KIT) on the topic of hail risk modeling and "Vulnerability and Risk" (GPI/KIT) related to earthquakes.

The Social Vulnerability and Integrated Risk Project in GEM which is co-funded by Willis will deliver indicator methods and an open source software that will be integrated into the GEM OpenQuake Platform. The indicators and the indicator toolkit (software) can be used worldwide to explore the compounded nature of earthquake events through consideration of factors related to socio-economic vulnerability and development of global and sub-regional socio-economic databases. Uses cases in Japan, Kathmandu (Nepal) and Quezon City (Philippines) are also developed for the application of the indicator tools for various contexts and different scales of geography.

In the first project, CEDIM still works on the hazard component of the Willis European Hail model WEHM which estimates frequency, extent and severity of hail events (see the article "The Challenge of Hail Hazard and Risk Modelling" earlier in this annual report). The model is based on overshooting top data from METEOSAT Second Generation (MSG) satellite as a proxy for hail. This method leads to a unique, spatially homogeneous event data set covering continental Europe. The risk component of the model is done by Willis. Currently the WHEM model is used by more than 20 insurance companies. A close collaboration on a day-to-day basis quickly developed between the Willis CatNat team in London and KIT atmospheric risks group fostered further devel-

opment and improvement of the WEHM. Model specifications were continually reviewed based on needs and available data.

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Sparkassenversicherung SV

Within the framework of the project HARIS-SV (Hail Risk SV), IMK developed a novel and unique hail model for the SV Sparkassenversicherung insurance company. This hail model considers several thousands of footprints from past hailstorms in Germany estimated by combining radar data from the German Weather Service (DWD) with lightning data from Siemens and insurance loss data (see the article "The Challenge of Hail Hazard and Risk Modelling" in this annual report). Currently, the hail model is further improved and calibrated by considering adjusted hail-size distributions and different damage functions based on loss experiences of past hailstorms. Furthermore, a modified version of the HARIS-SV model is developed that allows for estimating overall losses in near-real time, which can be used in the case of a CEDIM FDA activity where hail is important.

In 2014 a new 3-year project was established between CEDIM and the SV within the project FLORIS-SV (Flood Risk SV Sparkassenversicherung). This project aims at estimating damage related to widespread extreme flood scenarios based on stochastic modelling of precipitation processes and resulting floods. A special focus will be put on events that occur simultaneously in different catchment areas, thus leading to extreme loss situations. In the first step, the area under investigation is restricted to the federal state of Baden-Württemberg, where the SV portfolio is large. Involved in the project are IMK-TRO (WG Atmospheric Risks), IWG (Abt. Numerical Models in Hydraulic Engineering and Dep. Hydrology), and James E. Daniell.

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Cooperation with alpS - Centre for Climate Change Adaptation

The alpS – Centre has been established as a K1-Centre of the Austrian Competence Centre Programme for excellent Technologies and as such is an independent, non-university research and development platform with its focus on natural hazards, risks and climate change adaption in Innsbruck, Austria.

After the first meeting in November 2013 in Innsbruck and the agreed „Memorandum of Understanding" both CEDIM and alpS acknowledge the similarities in the scholarly pursuits of the institutions and the desire to promote inter-institutional cooperation, scientific, technical and cultural exchange, and mutual understanding. Since then, the cooperation was intensified in terms of projecting and scheduling a joint workshop in 2015 on the exchange of experience, students and staff, and establishment of joint research and development programmes concerning Disaster Risk Reduction, Risk Management and Climate Change Adaption.

Stakeholder Interactions for Near Real-Time Forensic Analysis of Disasters

Introduction

The Forensic Disaster Analysis (FDA) research in CEDIM requires innovative approaches for ab-initio engagement with stakeholders with clear definitions of mutual needs and processes of engagement and interaction. For this purpose it is necessary to understand the operations and organizational characteristics of the respective stakeholders, what their needs are and the extent to which FDA can contribute to them. To support and structure the sharing of information at the time of an event, a series of engagements were planned with carefully selected group of stakeholders to map their needs and identify exchange and interaction processes.

Aims/Objective

Stakeholder interactions were planned and carried out among both public and private sectors, including civil protection, humanitarian aid, insurance/re-insurance and scientific organizations. The two overarching goals of these activities were to (a) engage both scientists and stakeholders in a dialogue to discover the needs of potential FDA beneficiaries in the context of CEDIM's FDA mission, and (b) provide input to further develop and improve FDA tools/methods for obtaining meaningful parings of FDA research outputs and end user uptake.

The results (positive or negative) of interaction with each of the stakeholders were documented in a form that includes the detailed contacts, the essentials of the discussions, the identified user needs and reflections on the interactive processes and protocols to transfer FDA analyses and modeling results into relevant outputs that could better serve the needs of the respective stakeholders.

Project Status

From July 2013 until May 2014 CEDIM researchers held nine workshops/meetings with key representatives of several organizations within both public and private sectors. These include meetings with the Federal Office of Civil Protection and Disaster Assistance (BBK) on July 5, 2013; USAID Office of Foreign Disaster Assistance (OFDA) on August 2, 2013; Euro-

pean Commission – Humanitarian Aid and Civil Defense (DG-ECHO) on September 9, 2013; German Red Cross (DRK) on September 22, 2013; Technische Hilfswerk (THW) on October 17, 2013; Google Crisis Response and Google Earth Engine on December 17-18, 2013; Guy Carpenter on January 30, 2014, UNESCO Natural Disaster Reduction (SC/DRR) on March 6, 2014 and Griffith University (Crisis Communication) on May 5-7, 2014. Prior to each meeting a background document is prepared where areas of common interest related to FDA activities are documented and used as a basis for developing the meeting agenda and steering the discussions. Several research themes were identified to be of potential interest to stakeholders based on these engagements and have been selected for follow-up. These include: near real-time evaluation of public communication of disaster impacts (USAID); near real-time prognosis of causality, displaced persons and economic losses (DG ECHO/JRC); near real-time shelter needs evaluation (German Red Cross).

Concluding Remarks and Outlook

The initial set of stakeholder interactions have resulted in a set of recommendations for structuring the FDA reports which represent a wide spectrum of views. For example, while some users thought that the FDA reports were too long and text heavy, others saw the reports as "not going deep enough". Similarly, among the different sectors we engaged with were some who thought that 10 days was an appropriate interval for releasing the reports, while others reported that they would need information on likely impacts within several hours of the first day. In general, representation of key information through a one page summary and graphical abstract was recommended and taken up by CEDIM in structuring the report. Furthermore, the use of a web-based application and platform for uploading and sharing geospatial information from the FDA investigations such as GeoNode is currently being discussed at CEDIM.

Overall, it was agreed that more of CEDIM's own analysis should be captured in the FDA reports and that follow-up reports beyond the initial period are desirable. Ideally these should

be combined with on-site investigations and based on clear areas of contribution in targeted partnerships. Currently, research into public communication of disaster impacts - including a field investigation following Typhoon Haiyan - is being planned in the Philippines and targeted engagements with stakeholders on site have been sought.

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