Content

Imprint

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Preface

The Center for Disaster Management and Risk Reduction Technology (CEDIM, www.cedim.de) is an interdisciplinary research center in the field of disaster management supported by two Helmholtz Centers – the Helmholtz Centre Potsdam - German Research Center for Geosciences (GFZ) and the Karlsruhe Institute of Technology (KIT). Research within CEDIM is currently focussed in two research areas: ‚Natural Risk and Climate Change‘ and ‚Monitoring of the Global Risk Dynamics‘. In both areas we address risks from the perspective of natural hazards, vulnerability of the society and mitigation of risks. The research group ‚Natural Risk and Climate Change‘ develops high resolution precipitation patterns with emphasis on extreme precipitation. They are linked to two hydrological models. In the end we will have a calibrated set of precipitation and hydrological models available; an entire ensemble of future scenarios. It allows not only studying the changing flood hazards but also provides error bounds on these predictions. An intensive discussion between various stakeholders has been already initiated.

CEDIM participates in the Global Earthquake Model (GEM, www.globalquakemodel.com) where we are responsible for the regional programme in Central Asia, where the harmonisation of regional risk assessment has made major progress in the past 2 years. In addition we participate in a GEM funded project dealing with procedures that aim at the capture of global inventories. In addition we develop - as key partner - the frame and concept of socio-economic components of risk assessment and mitigation.

The third (emerging) field of CEDIM activities are risks related to critical infrastructures. In an assessment program (SIMKRIT) research and practitioners‘ needs have been identified; in consequence the program KRITIS is under development aiming at a decision support tool for critical infrastructure ranging from operational via technical to strategically decision support. This is being done in partnership with Fraunhofer IOSB as a new key partner to CEDIM in this field. The work on crisis management in case of interruption of power supply – with Baden-Württemberg as an example – has been finalised with significant input from CEDIM partners, but also in cooperation with the Federal Office of Civil Protection and Disaster Assistance.

(Bundesamt für Bevölkerungsschutz und Katastrophenhilfe - BBK). The result of this project is a handbook that found wide distribution in cities, fire brigade departments and communities.

The cooperation with insurance industry has continued; Willis Research Network is funding a position in CEDIM. Intensive cooperation has been developed with SV Sparkassenversicherung after the initial meeting in 2009, particularly in the field of hail and earthquake risk.

A new initiative that emerged in the aftermath of the eruptions of the Eyjafjallajökull volcano in Iceland in April 2010 is the development of a Helmholtz Task Force for major disasters, which tries to synthesize and visualize the capacities of various Helmholtz institutes with activities in disaster risk mitigation. The three focal institutions are: GFZ, KIT and German Aerospace Center (DLR), with the intention to expand this to the entire set of EOS Helmholtz institutes. Concepts have been developed and work has started in December 2010.

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I. Research

Natural Risks and Climate Change

Introduction

In 2007 the fourth IPCC status report stated that it is “very likely” that the number of extreme weather events such as winter storms and heavy precipitation will increase due to the climate change caused by human activities. This means that protective measures will fail more frequently and that damage related to natural hazards will increase in the future. Additionally, a growing damage potential due to social and economic change (demographic change, change in land use, increasing values, and increasing cross-linked infrastructures) can be expected. In consequence, risk as a product of expose and vulnerability increases significantly in the future.

The challenge of changing risks is met by the research focus within CEDIM “Natural risks and climate change”. Central to this research focus is the project on a changing flood hazard in small and middle size river catchments due to climate change and the project on hail risk in Southern Germany. Besides, climate change scenarios are integrated in research activities on flood vulnerability of transport infrastructure, on indicators for the quantification of indirect damage as well as on impacts and protection measures in case of a disruption in energy supply and telecommunication (see chapter on vulnerability and critical infrastructures).

In the joint project “Flood hazard in a changing climate” data from global climate models is used to perform high resolution climate simulations (7 x 7 km²). The results are then used to drive water management models and the WASIM, SWIM and PRMS discharge models and finally to study changes in heavy precipitation in three river catchments (Ammer, Mulde, Ruhr). Besides, the data obtained in the regional climate modeling is used in the CEDIM research project HARIS-CC (Hail Risk and Climate Change) to quantify the hail hazard for Germany in a high spatial resolution and to assess trends for the future.

Outlook

The aim of the project activities at KIT and GFZ is to expand the research on change in flood and hail hazard to the related change in risk from flood and hail. For hail, a hail loss model will be developed. Regarding floods, a risk analysis for the Mulde river catchment is already being performed. Here, the influence of the components climate change, change in land use, and change in building values is quantified in a sensitivity analysis. It is planned to apply this to the Elbe river catchment in the next year.

Parallel to finalizing the joint project “flood hazard in a changing climate” a follow-up project will be developed that generates added value for the individual works by its interdisciplinary orientation, which ensures CEDIM a unique position in the research community.

Flood hazard in a changing climate

Introduction

Several studies indicate an increased variability in precipitation and temperature for the warming future climate. This means that extreme events might become more common, and possibly have a significant impact on society. Due to the rarity of extreme events, it is a complicated task to identify changes within the variability and uncertainties of short time-series. Furthermore, it is important to know what happens on the smaller scales, e.g. for individual countries or river catchments to develop suitable adaptation strategies. Therefore, a combination of large scale climate projections with global and regional climate models (RCMs) and hydrological models (HMs) is commonly applied.

Aims / Objectives

Two RCMs are used to downscale general circulation model (GCM) for present conditions and future projected levels of greenhouse gases. The RCM downscaling provides the HMs with the needed meteorological input data on a 7 km resolution grid, in comparison to the GCM resolution of ~200km. This high resolution is much closer to the scale of the HMs, and the catchments to model. A small ensemble of climate simulations is simulated and uncertainties due to natural variability and the models used (GCM, RCM, HM) will be compared. This allows for assessing climate change signals in context of the large uncertainties involved in the modeling.

Project Status

Three realizations of the ECHAM5 model have been downscaled with the COSMO-CLM (CLM) RCM at Institute for Meteorology and Climate Research, Troposphere Research (IMK-TRO). The CCCma3 GCM is being downscaled additionaly in order to enlarge the size of the ensemble and to consider the uncertainty in the climate change impacts due to the used GCM. One realization of the ECHAM5 model has also been downscaled using the WRF RCM at Institute for Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU), in order to explore the uncertainty due to the downscaling model. In Figure 1, a comparison of the control period performance of the CLM and WRF models is presented, and also the freely available REMO [Jacob et al., 2008] simulations at 10 km resolution are included. The CLM model is colder than the observations by about 0.5 to 2 K, while WRF and REMO both have a warm bias of around 0.5 K. Precipitation is overestimated by all three models, but

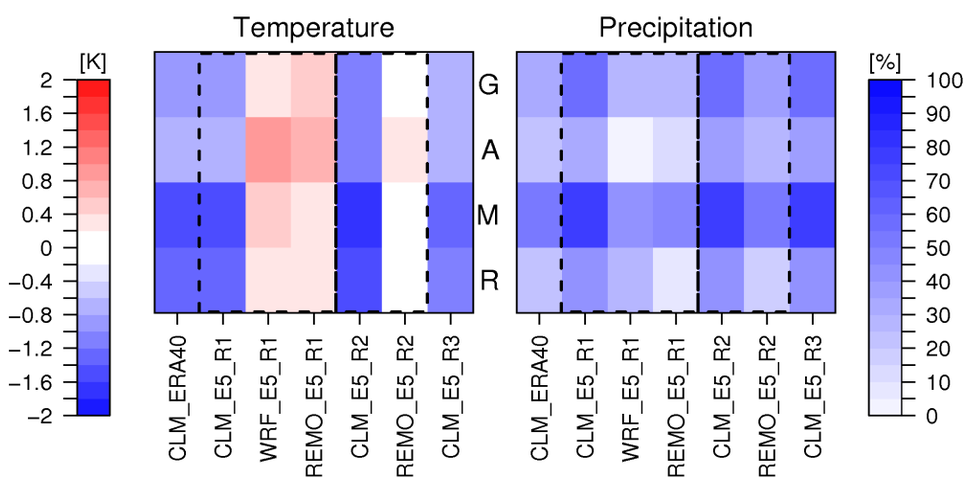

Fig. 1: Annual mean bias for the CLM, WRF and REMO control simulations (E520C) for the different realizations (R1—3), as well as an ERA40 driven simulation with the CLM. Spatial averages are shown for the regions Germany (“G”), Ammer (“A”), Mulde (“M”), and Ruhr (“R”). Temperatures are compared to the E-OBS data set [Haylock et al., 2008], and precipitation to the REGNIE data set (DWD).

it should be noted that some of the bias also comes from the ECHAM5 model. The wet bias is larger in winter for CLM and WRF, whereas REMO has a large bias in autumn (not shown).

The large biases in the RCMs need to be corrected before coupled to the HMs, and a bias correction often referred to as the quantile mapping method is implemented at IMK-TRO and applied to the simulations [Berg et al., 2010]. The method corrects the whole distribution of the variable, and the mean and variability are then trivially corrected. The unavoidable assumption when bias correcting is, that the bias is not changing with the climate. It is therefore important to make sure that the bias correction method does not affect the change signal in the data. This is currently under investigation at IMK-TRO.

Three hydrological models are each being applied to two of the three selected catchments Ammer, Mulde, and Ruhr. As an example, the hydrological model SWIM is set-up for the Mulde and Ruhr catchment at GFZ. The model is calibrated subcatchment specific, using the SCE-UA algorithm [Duan et al., 1993; Duan et al., 1994] over a period of five years (1991-95). As objective function a weighted sum of Nash-Sutcliffe efficiency, a modified efficiency giving higher weight to flood peaks, log efficiency and volume bias is used. The results are satisfactory with median efficiency values of 0.7 to 0.8 and model biases smaller than 10 %. The performance of the model is also evaluated visually with respect to daily flows, average and maximum monthly flow regimes, average and maximum annual discharges, and flow exceedance curves. After successful model calibration using observed climate input, the SWIM model is run, using bias corrected RCM data as climate input. Model simulations with observed and RCM climate input over the control period 1971-2000 are compared in order to check that the average statistical behaviour (AE), like flow exceedance curves and monthly average and maximum flows, is reproduced (Fig. 2).

The Institute for River Basin Management (IWG) set up the hydrological Model PRMS [Leavesley & Stannard, 1995] for the Ruhr catchment. To regard the varied water management systems in the Ruhr catchment, in addition, the model system BEWASY [Brudy-Zippelius, 2003] is applied. The hydrological model system is calibrated for the hydrological years 1992-1993 and validated with longer time series (20-30 years). The results show over all mostly satisfying and good efficiency criteria.

For the hydrological statistical analyses the IWG focused at first on the three realizations of the RCM control run (ECHAM5, CLM, 1971–2000). Figure 3 shows exemplary the gauge Bamenohl, Lenne with the annual hydrological regime of the mean flow for the three realizations with and without bias-correction. Significant is the obviously strong impact of the bias corrected precipitation and temperature to the flow reactions in the catchment.

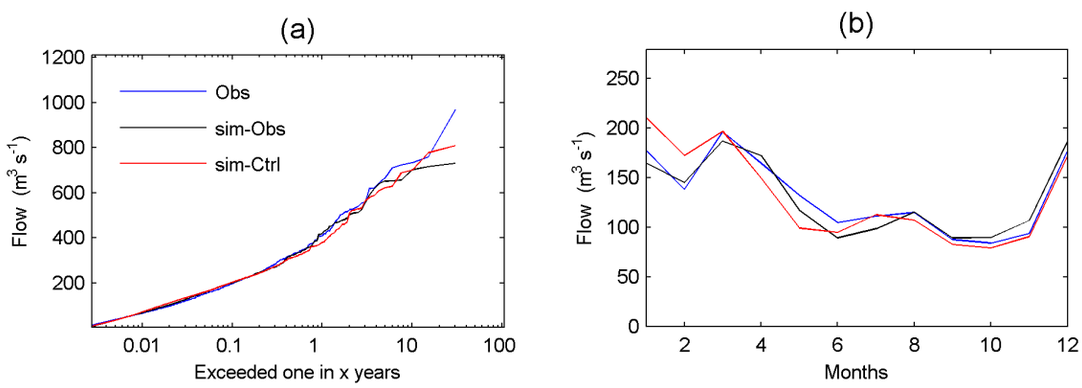

Fig. 2: Results of the SWIM run with bias corrected 18 km CLM data for the control period 1971-2000 (sim-Ctrl) compared to SWIM simulations with observed input (sim-Obs) and observed discharge (Obs) at gauge Golzern, Mulde. (a) Flow exceedance curve, (b) average maximum monthly discharges.

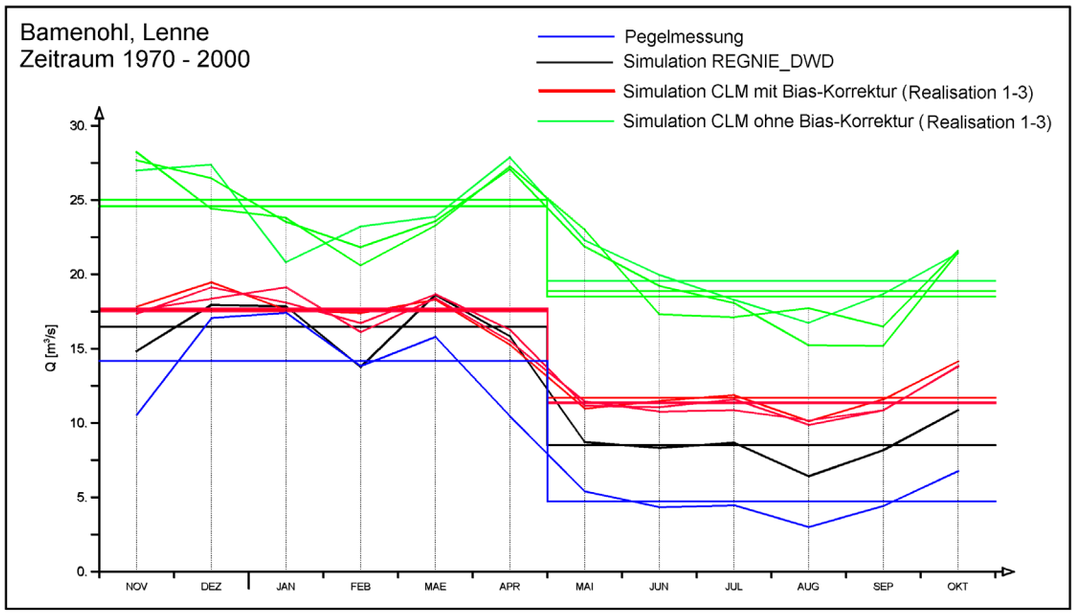

Fig. 3: Exemplary gauge Bamenohl (Lenne) annual hydrological regime for mean flow of the three realisations of the RCM (ECHAM5, CLM, 1970-2000) with and without bias-correction.

Hydrological simulations using WaSiM for the Ammer and Mulde catchment are in progress. The required input fields for the WaSiM setup are compiled and the basins are delineated into six sub-catchments for the Ammer and 22 sub-catchments for the Mulde. The model setup is currently calibrated and validated using observed meteorological station data and discharge time series, before the application of RCM results as meteorological driving data will be performed.

Outlook

The set-up and calibration of each of the HMs is close to completed, and control period simulations are available for each of the catchments. The next step is to perform the future scenario simulations and compare to the control simulations. A detailed plan for the assessment on the climate change signals in different variables and how the transfer of the climate signal from the meteorological to the hydrological data is affecting the response is being produced. The use of multiple models for each step of the project allows for assessing the uncertainties involved in this kind of studies.

Publications

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HARIS-CC

Hail Risk and Climate Change

Introduction

Over the last decades, loss due to severe hail storms increased significantly in Central Europe. Thus, hail is meanwhile responsible for more than 40 percent of all building damage caused by natural hazards in Baden-Wuerttemberg (1986-2008). In order to take this change in hazard into account, quantifications of the hail hazard and risk as accurate as possible are vital for economy, especially for the insurance industry. Furthermore, the question arises to what extent the increase of hail losses is caused by the anthropogenic climate change.

Due to the local-scale impacts of a few hundred meters to some kilometers only, hail cannot be recorded or simulated sufficiently by current measuring systems or numerical models, respectively. Therefore, several data sets are combined and analyzed statistically within the project HARIS-CC, which is part of the activities of CEDIM since June 2009. The aim of the project is quantifying the hail hazard for Germany in a high spatial resolution as well as assessing trends for the future.

Aims / Objectives

Based on radar data of the German Weather Service (DWD) and the Lightning Information Service of Siemens (BLIDS) tracks of single hailstorms from the past are reconstructed by a cell tracing algorithm. In order to exclude events without any loss-relevant hail, additional observation data was used. This encompasses aerological data and data obtained from stations as well as loss data from insurances (SV Sparkassenversicherung and Vereinigte Hagelversicherung), complemented by web-based information (see project „Humans as Sensors“). In order to ensure a sufficient number of samples for the application of statistical methods, synthetic hailstorm tracks are generated using stochastic modeling and taking into account predominant meteorological boundary conditions. The application of extreme value theory then allows estimating the intensity as a function of the return period. Furthermore, a hail loss model is created, which enables to convert the measured and modeled intensities (e.g., radar reflectivity or hail kinetic energy of hail) into monetary parameters like mean loss or maximum loss. From that, it is possible to quantify the hail risk for certain return periods based on a local scale.

Long-term changes of the atmospheric conditions for thunderstorm development are quantified from an ensemble of high-resolution regional climate models (RCM). A substantial part of the ensemble are RCM calculations carried out in the project “Flood hazard in a changing climate”. First of all, the occurrence probability of past hail events is described statistically in a multi-dimensional parameter space of appropriate atmospheric indicators (e.g. convective energy, divergence of the moisture flux, general circulation patterns) derived from re-analysis data and radiosonde observations. Afterwards,

the methods adjusted to real events in the past are transferred to the climate projections. The alteration of the convection potential can be quantified by the difference of the relevant indicators between past (e.g. 1971-2000) and future (e.g. 2021-2050) periods. This allows to project the expected hail hazard in the future on basis of the past hail hazard.

Project status

First results were obtained for a test region in Baden-Wuerttemberg, where extensive and high-resolution data already has been available (see annual report 2009).

Due to their high spatial and temporal resolution as well as their coverage of whole Germany, radar and lightning data appear especially suitable for the detection of severe thunderstorms and the determination of their tracks. As lightning strokes can be localized very precisely over great distances by electromagnetic sensors, it was initially analyzed to what extent positive and negative lightning as well as a certain lightning frequency can be linked to hail and a certain radar reflectivity respectively. It was shown by several case studies that an increased lightning activity in a certain area coincides with a particular high radar reflectivity. Considering the distribution of charges, negative lightning particularly dominate during the developmental stage of a storm, whereas positive lightning accumulate during its maturity. It is also evident that negatively charged lightning show a lower spatial distribution during developmental stage, while positive lightning can also occur further away from the center of the storm (Fig. 1). The established relation enables to reconstruct radar reflectivity indirectly from the lightning data in those areas, where the radar signal is blocked by obstacles.

Statistic analyses of the convection indices, which describe the stability of the atmosphere, reveal that the storm potential has already considerably changed in recent years (Fig. 2). Radiosounding measurements in Germany and Europe during the summer half-year around 12 UTC served as data basis for this research. According to the analyses, a change in direction of the trend has taken place over Germany in the past 50 years. While the potential for severe storm development was lower during

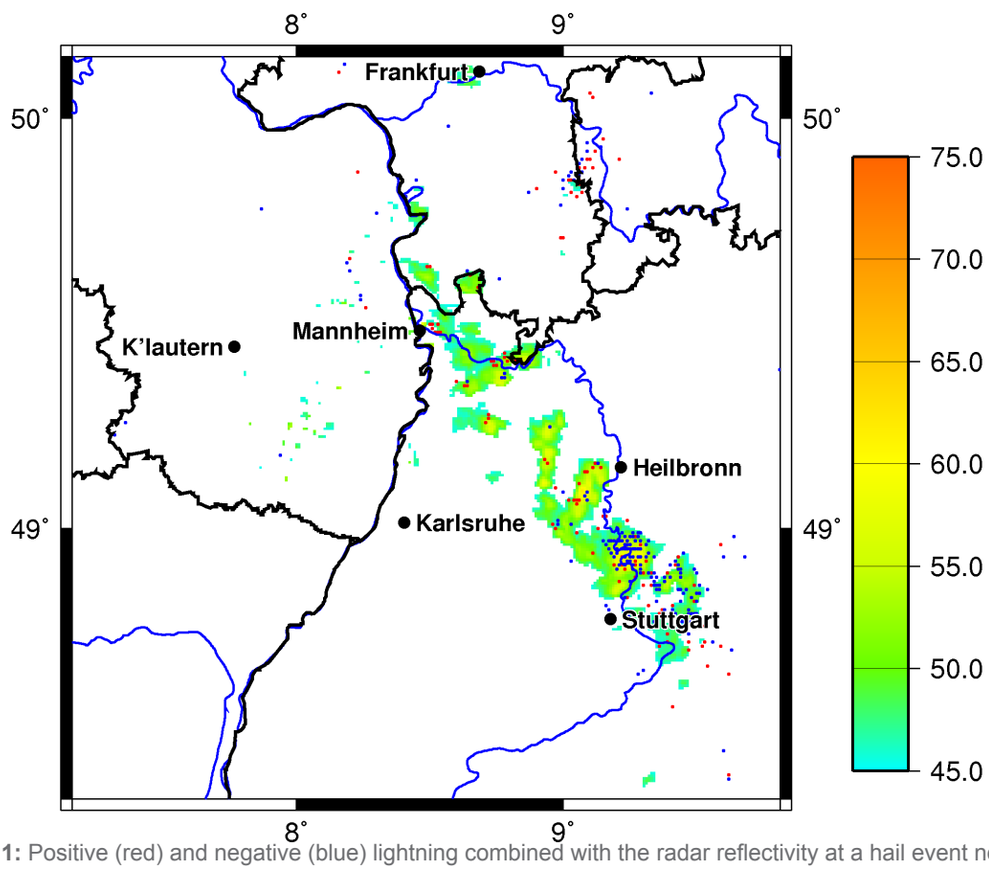

Fig. 1: Positive (red) and negative (blue) lightning combined with the radar reflectivity at a hail event north of Stuttgart on the 25th of June at 9 pm UTC.

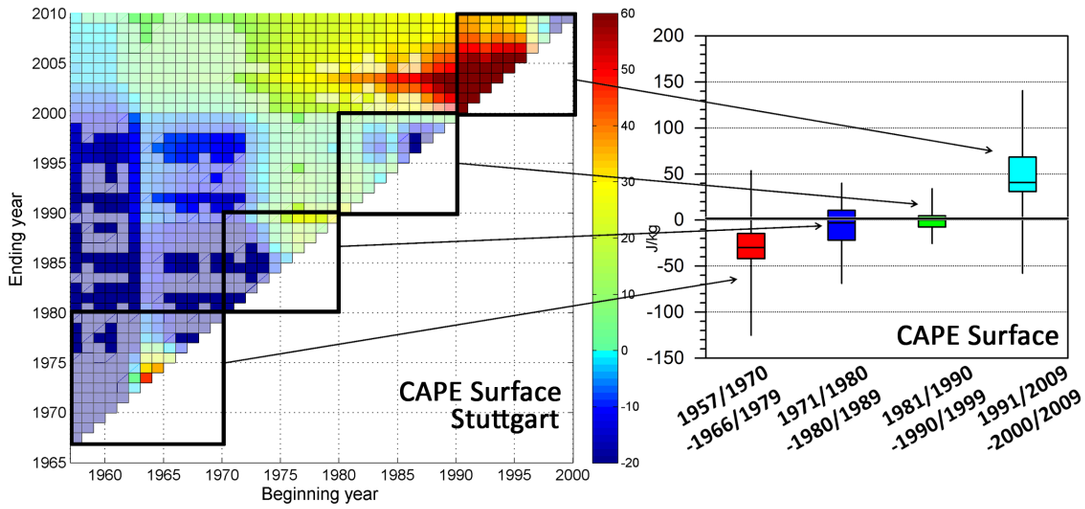

Fig. 2: a) Linear trends of the annual 90 percent percentile for varying time periods (time frame at least ten years) for the available convective energy (CAPE) at the station of Stuttgart; the x-axis marks the beginning, the y-axis the end of the respective time row. b) Corresponding boxplots for the linear trend of various variable time rows.

the 1960/70s, it increased significantly in the 90s. Thereby, the change happened earlier in the South than in the North. A similar development took also place in Central Europe. The changes in the convection indices are mainly determined by an increase in temperature and humidity on layers close to the surface representing the local conditions.

In order to establish a relation between various convection indices and hail events, the indices are compared with building and agriculture loss data by categorial verification. It is found that single indices (e.g. CAPE or Lifted-index) are able to imply storm or hail development, at least on average.

Outlook

In the next two years the mentioned work steps will be implemented.

The project HARIS-CC is supported by the foundation Umwelt und Schadenvorsorge, by Willis Research Network (WRN) and by the SV Sparkassenversicherung.

Existing cooperations

SV Sparkassenversicherung, Stuttgart
Vereinigte Hagelversicherung, Gießen
Willis Research Network (WRN), London
Blitz Informationsdienst von Siemens (BLIDS)

Publications

Kunz, M., Puskeiler, M. (2010): High-resolution assessment of the hail hazard over complex terrain from radar and insurance data. Meteorol. Z., doi: 27/0941-2948/2010/0452.

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Estimation of upper bounds of flood discharges in Saxony

Introduction

This study was part of the project „Synopsis of natural hazards in Saxony“, in which the risks of three different hazards (earthquake, flood, wind storm) were compared. For a consistent comparison of these three natural hazards the overlap in the considered recurrence intervals had to be maximized. Therefore, flood discharges were estimated for very large recurrence intervals in the range of 100 to 1000 years to improve the estimation of discharges with a recurrence interval > 100 years.

Aim of the project

The aim of this project was the derivation of extreme flood discharges with large recurrence intervals and the estimation of upper bounds of flood discharges using probabilistic regional and empirical envelope curves. In a second step, these flood discharges were integrated into distribution functions. By using the additional information of extreme discharges and their corresponding recurrence intervals, the study was tailored to improve the estimation of flood discharges with a large recurrence interval.

Final project description

This project investigated envelope curves. These are boundary lines above all observed flood discharges in a region. This study was based on continuously measured discharge time series at evenly distributed gauges in Saxony. Preliminary studies revealed that the uncertainty of the existing approaches of empirical and probabilistic regional envelope curves had to be thoroughly examined. Only then, an improved estimation of discharges with large recurrence intervals could be achieved.

The suitability of two methods to derive homogeneous regions of catchments was investigated by a sensitivity analysis. The sensitivity analysis leads to an estimation of the variability

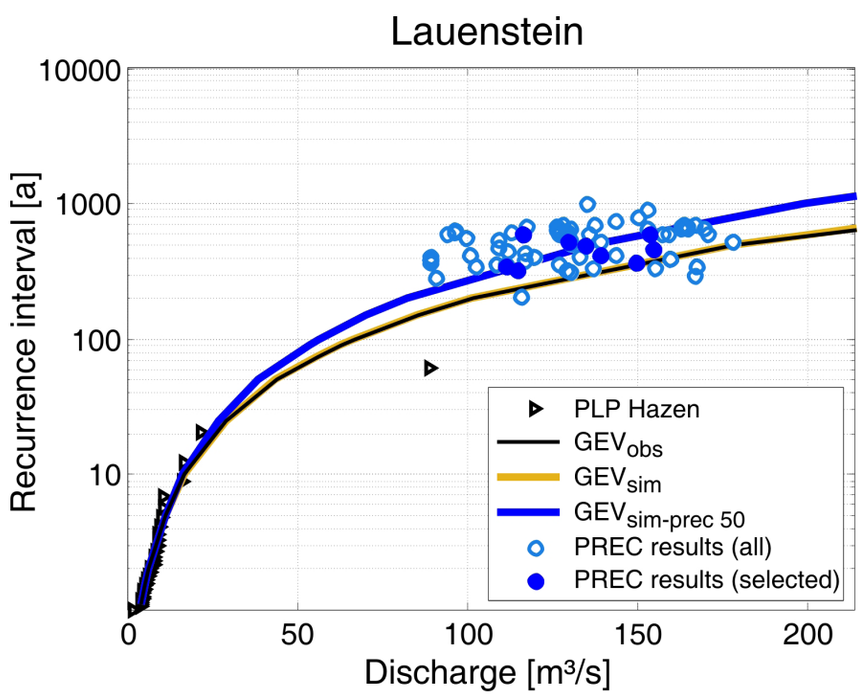

Fig. 1: Combination of traditional flood series with the results of probabilistic regional envelope curves for the gauging station Lauenstein (from Guse et al., 2010b). The observed flood series are shown as plotting position (PLP Hazen) and used for the traditional generalised extreme value distribution (GEVobs). Each blue circle symbolise one realisation of the probabilistic regional envelope curve. The flood discharges and their corresponding recurrence intervals derived by probabilistic regional envelope curves (PREC results) were combined with a GEV. The blue line (GEVsim-prec 50) represents a medium behaviour of the combined distribution function.

of probabilistic regional envelope curves. The effects of cross-correlation among flood series on the recurrence interval of a probabilistic regional envelope curve were examined in another study. Both studies improve the estimation of the extreme discharge and its corresponding recurrence interval of a probabilistic regional envelope curve for the considered gauges. The results of these two studies were both presented on international conferences (Guse et al., 2008a, 2009b, 2010a) and published in peer reviewed journals (Guse et al., 2009a, 2010c).

The results of the probabilistic regional envelope curves were used as additional information in flood statistics. Whereas the traditional flood statistic only allows reliable estimates up to recurrence intervals of 100 years, in this study probabilistic regional envelope curves provide additional points for recurrence intervals between 150 and 1500 years. By using them, the uncertainty in flood frequency studies was reduced.

In the last step, the results of envelope curves were integrated into a suitable distribution function, which was developed in cooperation with the subproject „Real-time damage assessment of winter storms“. First, the results of the probabilistic regional envelope curves were combined with the traditional flood series (Fig. 1). Second, the empirical envelope curve was used as an upper bound discharge. Hence, both types of envelope curves were included into a mixed bounded distribution function (Fig. 2). By integrating the upper bounds, the estimates of flood discharges were limited and an unbounded increase up to discharges with unrealistic high values for high recurrence intervals was avoided (Fig. 2). This study was also presented on an international conference (Guse and Merz, 2010) and was submitted to an international journal (Guse et al., 2010b). The cooperation of GFZ and KIT in CEDIM was shown by contributions of authors from both institutions to this manuscript.

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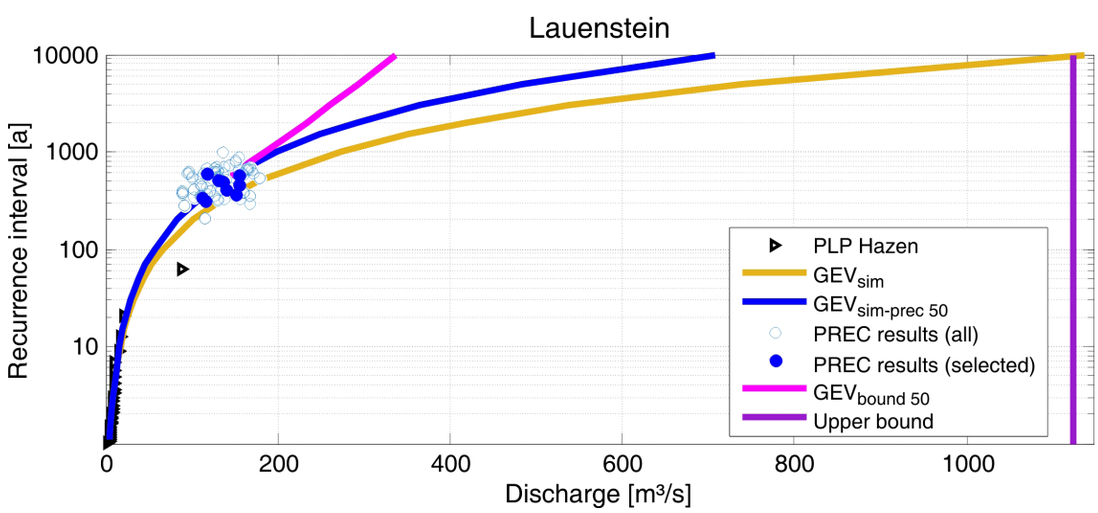

Fig. 2: Illustration of the mixed bounded distribution function (GEVbound 50) in addition to the traditional GEV (GEVsim) and the combination of observed flood series and the results of probabilistic regional envelope curves (GEVsim-prec 50) for the gauging station Lauenstein (from Guse et al., 2010b).
An asymptotic approach to the upper bound derived from an empirical envelope curve is considered for recurrence intervals larger than 500 years in (GEVbound).

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Global Risk Change: Global Earthquake Model GEM

GEM is a worldwide public/private partnership with the aim of providing the scientific and functional requirements for mapping, analyzing and monitoring of global earthquake risk and sets out to serve as an integral technology and tool to support decisions and actions that reduce earthquake losses. Within GEM earthquake risks will be calculated worldwide using a uniform and independent standard based on a state-of-the-art, dynamic and open model for the assessment of seismic risk and communicated in a manner that is understandable to all users. Founded in March 2009, more than 50 research institutes worldwide contribute by now to developing the global model and additional 100 institutions are integrated in supporting regional activities. CEDIM has become an important partner and has included the development of tools for analyzing the global earthquake risk and its dynamics as a special focus in CEDIM's research program. In 2010, CEDIM participated in the following GEM acitivities:

1. Participating in an international team to build the concept for a *seismic risk module within GEM 1* (pilot project). Based on test-bed modeling for cities such as Lisbon, Istanbul, and Bukarest, strengths and weaknesses of 9 existing risk software codes, including the CEDIM loss codes, were critically reviewed with international partners, which provided relevant input for setting up an optimized global model of seismic risk.

2. Initiating a *GEM regional program Central Asia* within the project CASCADE funded by the German Federal Foreign Office (see extra report below). One major goal of this initiative is to perform a cross-border risk analysis for the Central Asia region.

3. Contributing to an international consortium to develop the „*GEM Inventory Data Capture Tool*". CEDIM's task in particular is to design a method which allows a quick survey of the structural vulnerability of mega and major cities (see short report below). First results based on a novel approach that combines satellite and street-view-data have already been achieved for Bishkek/Kyrgystan.

4. Developing a concept for *analyzing the socio-economic impacts* of catastrophic earthquakes. CEDIM has been represented in an international consortium that prepared a "Road Map" for including the socio-economic impacts in GEM (see report below).

5. Installing the "*GEM-Testing Center*" at the GFZ. In this center the quality of all modules and components developed for the GEM-Model are to be validated independently from the developers and tested in replicable, transparent scientific experiments under controlled conditions. These activities commenced with the transfer of the Science Lead of CSEP (Collaboratory for the Study of Earthquake Predictibility) Dr. Schorlemmer (Southern California Earthquake Center) to the GFZ in August 2010.

Within CEDIM's research on global earthquake risk modeling, further research activities are carried out that are not directly linked to GEM-supported activities. Among these also is a project on *Remote Sensing and Population estimation* and the optimization of an *Open Source Procedure for Assessment of Loss using Global Earthquake Data.* Some of the GEM-activities within CEDIM are presented in the following sections of this chapter.

Central Asia Initiative: From CASCADE project to an improved risk assessment for Central Asia

Global Earthquake Model GEM

Introduction

Central Asia was identified as one of the regions of the world with the highest seismic hazard and risk. However, the actual lack and heterogeneity of available seismological and vulnerability data make any possible seismic risk scenario highly uncertain. In order to improve seismic risk assessment in Central Asia efforts must be carried out to both increase the seismological knowledge in the area and to update and harmonize the existing vulnerability data set in the different countries. To this aim, the German Federal Foreign Office financed the Central Asia Cross-Border Natural Disaster Prevention (CASCADE) project to develop a network of joint activities together with the Central Asian partners for seismic disaster awareness and preparedness. The three main directions along which the project developed were the installation of a cross-border seismic network, the seismic microzonation of two main towns, and the assessment of building vulnerability following a harmonized approach. Another important task of the project was the development of the capacity building component through the organization of several training courses.

The cross-border seismological and strong motion network in Central Asia (CAREMON) (Strollo et al., 2010) is composed by 6 digital stations equipped with both broad-band and strong-motion sensors. The stations have been installed in Kazakhstan (Podgornoe and Ortau), Kyrgyzstan (Talas and Sufy-Kurgan), in Turkmenistan (Ashgabat) and in Tajikistan (Djerino). The real-time communication is realized either via dedicated satellite link or through the internet network connection (only for Ashgabat). A further station has been delivered to the German Embassy in Tashkent (Uzbekistan) and the possibility to install the station with real time communication is under evaluation. A SeisComp3 system was also installed in the data centre of each partner, allowing the local scientists to receive, analyze and archive the continuous data streaming from different countries in Central Asia, as well as in the rest of the world through the GEOFONE and IRIS servers.

Within the CASCADE project strong efforts were devoted to collect data about the seismic vulnerability of the building stock in different countries. The major effort with the local partner was devoted to the harmonization of the vulnerability classification, converting, as a first step, the original local classifications (sometimes very different amongst the different countries) in a common EMS-98 scale. The possibility of developing an ad-hoc classification for Central Asian countries was discussed and efforts in this direction will be done in the near future. Future studies, already scheduled, will aim at updating the vulnerability data set. To account for the growing expansions of the urban areas in recent years and to provide comparable datasets satellite- and ground-based remote-sensing methods will be considered. All the collected information will be exploited in future collaborations for improving the seismic risk scenarios for Central Asia.

In order to improve the risk assessment in Central Asia, the hazard assessment has also to be improved considering, for example, the amplification of ground motion due to the geological and geotechnical characteristics of shallow layers. To this regard, microzonation studies in the capitals of Kyrgyzstan and Uzbekistan were started within CASCADE in collaboration with the Global Change Observatory Central Asia (GCO-CA) project. In particular, the investigation of site effects in Bishkek was carried out installing a temporary network of 19 stations within the town from August to December 2008 and performing single station noise analysis (Parolai et al., 2010). The analysis of the recordings of 56 seismic events and of nearly 200 measurements of seismic noise allowed to assess the spatial variability of the site response in the town, and to derive a map of the fundamental frequency of resonance of soil (Fig. 1). The results of the microzonation have been exploited for attempting an improvement of the risk assessment in the capital (Bindi et al., 2010). Although the data sets collected within the CASCADE project can be considered the most complete for the area, several issues are still open before better constrained earthquake risk scenarios for Central Asia can be calculated.

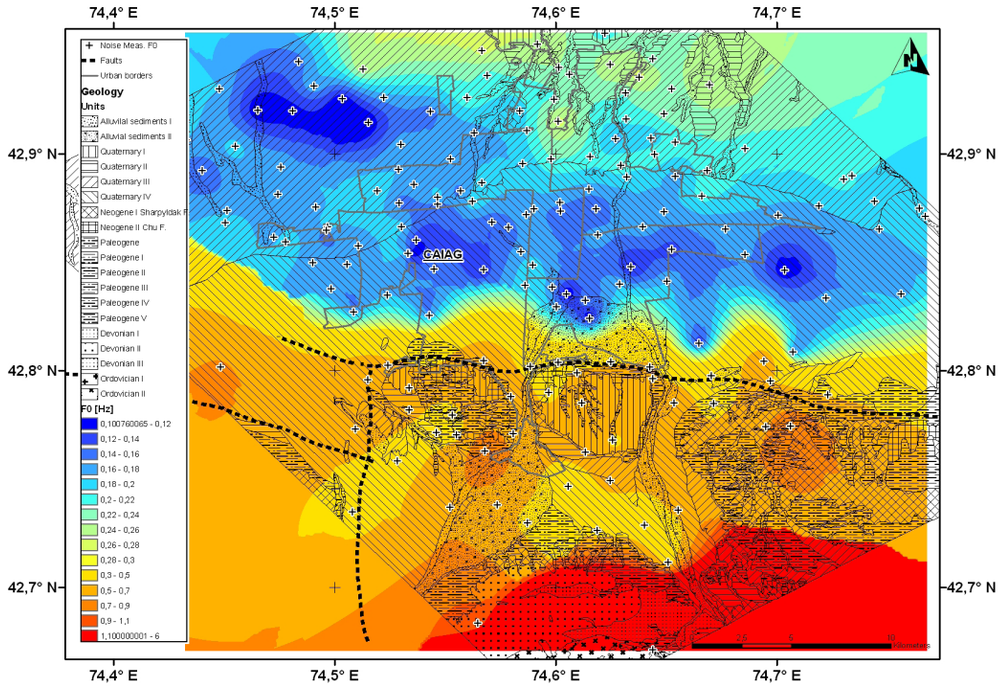

Fig. 1: Map of the fundamental frequency of resonance estimated from noise measurements for the area around Bishkek (Kyrgyzstan).

Aims / Objectives

The main aim of the project was to set up cross-border activities in Central Asia for natural disaster prevention. The digital data collected by this network allows to improve localization of the seismicity in the area and to improve completeness of earthquake catalogues necessary for sounded seismic hazard assessment at regional scale. Moreover, sharing data recorded in different countries using a homogenous system strengthen the collaboration among the different Central Asian partners. The seismic microzonation of Bishkek performed during the project allows to better quantify the expected differences in the hazard within the town due to local site effects. The collection of a harmonized (in terms of the European Macroseismic Scale EMS) building vulnerability data base allows the development of a risk assessment following international standards. The training of young scientists on this topic will allow to extend the activities to a wider territory and to refine the vulnerability composition models derived in CASCADE for the main towns.

Project Status

The CASCADE project ended in February 2010, and several activities triggered by the project are under development.

Outlook

Several activities carried out in CASCADE will be further developed in the framework of new projects and collaborations with Central Asian partners. An outlook of these developments is following:

- *Microzonation.* Site effects assessment in Bishkek highlighted the importance of this kind of investigations at least for the major towns in Central Asia. In fact, large amplifications of ground motion were shown to lead to significant increase of damage and losses. The possibility to extend the site effects assessment to other capitals, in particular to Dushanbe and Almaty, is under evaluation. In collaboration with GCO-CA, the installation of a vertical array is foreseen in Bishkek, allowing to improve our knowledge about propagation effects in the uppermost soil layers and to investigate the issue of non-linear site effects.
- *Network.* It will be evaluated the possibility of introducing in CAREMON some stations already installed in Central Asia and managed by local partners.
- *Vulnerability.* The seismic vulnerability composition models will be refined on a smaller spatial scale. Moreover, the vulnerability data set requires a continuous update. For

example, since the last census in the year 2000 in Bishkek, it was estimated that the number of buildings increased of nearly 20% (U. Begaliev, personal communication). In order to efficiently cope with such a rapidly changing urban environment, new methods for vulnerability estimation are adopted. Through extensive use of both freely available and commercial satellite data and advanced image processing techniques, a continuous picture of the urban scenario and its seismic vulnerability will be computed and kept up-to-date. A first assessment of the development of the urban area in Bishkek between 1976 and 2010 has been already carried out. Furthermore, the introduction of innovative technical approaches (e.g. the use of spherical imaging) will allow for detecting features of buildings (e.g. number of floors and presence of weak/soft stories) not available from satellite images. All these efforts will point towards the development of a comprehensive set of tools for building inventory, which would prove useful both in pre-earthquake risk and post-earthquake loss assessment.

- *Seismic hazard.* An attempt to improve the seismic hazard assessment for Central Asia is ongoing by exploiting the catalogs acquired during the CASCADE project. The development of indigenous attenuation laws for intensity is also attempted, and the calculation of probabilistic hazard for intensity will be soon performed.

Publications in international peer-reviewed journals

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Parolai S., Orunbayev, S., Bindi, D., Strollo, A., Usupayev, S., Picozzi, M., Di Giacomo, D., Augliera , P., D'Alema, E., Milkereit, C., Moldobekov, B., Zschau, J. (2010): Site effect assessment in Bishkek (Kyrgyzstan) using earthquake and noise recording data, Bull. Seism. Soc. Am, doi 10.1785/0120100044.

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Parolai, S., Orunbayev, S., Bindi, D., Strollo, A., Usupayev, S., Picozzi, M., Di Giacomo, D., Augliera, P., D'Alema, E., Milkereit, C., Moldobekov, B., Zschau, J. (2010): Site effect assessment in Bishkek (Kyrgyzstan) using earthquake and noise recording data, European Seismol. Commission 32nd General Assembly, Montpellier, France, September 6-10.

Parolai, S., Orunbayev, S., Bindi, D., Strollo, A., Usupayev, S., Picozzi, M., Di Giacomo, D., Augliera, P., D'Alema, E., Milkereit, C., Moldobekov, B., Zschau, J. (2010): Site effect assessment in Bishkek (Kyrgyzstan) using earthquake and noise recording data, European Seismol. Seismological Society of America annul meeting, Portland, Oregon, USA, 21–23 April.

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Tyagunov S., Begaliev U., Ilyasov I., Mavlyanova N., Ospanov A., Saidiy S., Yasunov P., Zschau J., Stempniewski L. (2010): Cross-Border Cooperation for Seismic Vulnerability and Seismic Risk Assessment in Central Asia „Problems of Seismology, Hydrogeology and Engineering Geology", Tashkent, pp.127-130.

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GEM - Socio-Economic Module

Introduction

In order to assess social and economic consequences of earthquakes, further and beyond the direct losses considered in the risk module, GEM plans to incorporate a Social and Economic Impact Module, intended to provide various stakeholders with a wide array of methods useful for analyzing impacts of seismic events. CEDIM has been participating in 5 workshops organized and sponsored by the GEM Foundation since September 2009 as part of a steering group, to develop a "road map" for the development of a socio-economic impact module in GEM. The working group organized at the OECD headquarters in Paris, France includes members from the World Bank, Applied Insurance Research (AIR), Munich RE, Oxford University, IIASA and CEDIM.

Aims / Objectives

The overarching goal of the GEM Socio-economic Impact Module (SEIM) is the establishment of uniform and open standards for calculating socio-economic impacts associated with earthquakes, under an open, participatory framework. The SEIM constitutes one of the three main pillars, together with the Seismic Hazard and Seismic Risk Modules, of GEM's modeling efforts. Its main *goal* is to contribute to improving our understanding of social and economic impacts from seismic events. The main *objective* of the SEIM is to provide the community research and academics, insurance industry, emergency managers with a set of methods for assessing, quantifying and communicating impacts of earthquakes on variables that are deemed as representative of the social and economic system. The toolbox shall be open for the community to incorporate methods of analysis of socio-economic impacts from earthquakes, following "meta-modeling" principles. In turn, such principles shall be also agreed upon with the community through a participatory platform, which, for instance, could take the form of a wiki.

The SEIM Steering Committee has recommended analyzing social and economic impacts of earthquakes according to spatial and temporal dimensions, and categories of stakeholders; which can help in organizing the social and economic impact engine (Fig. 1). Under this

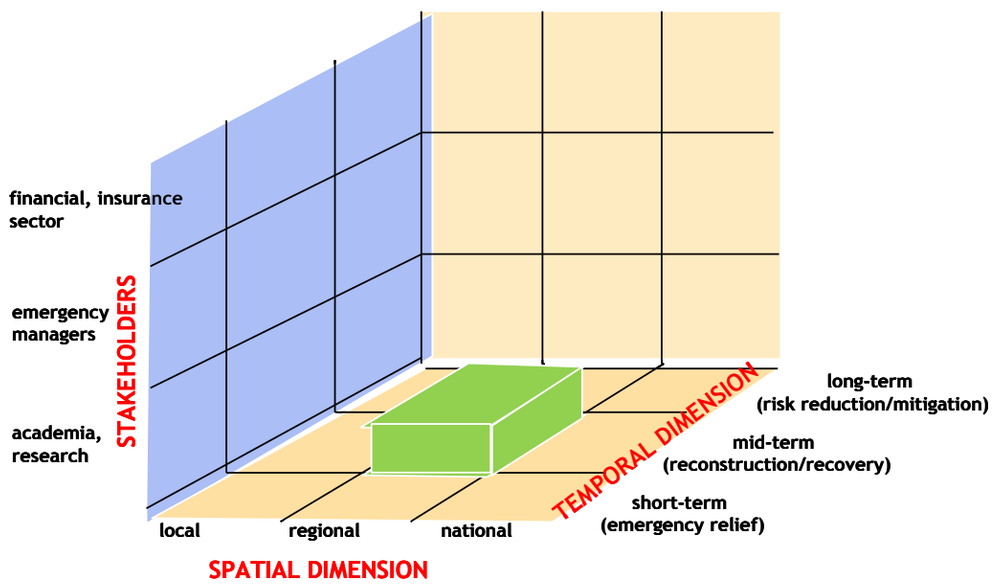

Fig. 1: Engine of SEIM.

particular classification, methods are spatially broken down by geographic extent or scale of analysis, relative to the place where the earthquake has direct physical effects; and temporally according to the *type of intervention* linked to the event. They are further allocated according to stakeholders who would, in theory, benefit from the insights obtained from the selected method. Furthermore, the methods could also be allocated depending upon the identification of stakeholders that would benefit from the insights they provide and the extent to which they would be willing to use them for guiding policy actions. It should be noted that a method can be allocated to more than one stakeholder. Methods can be additionally classified by levels of aggregation (from core data), sectors or institutions they cover, and by their overall goals (whether they are intended to generate indicators, serve as tools for analysis and insight, become a platform for sensitivity analysis, represent issues of vulnerability, etc.). Another common break down or distinction of methods refers to those pertaining impacts assessment and those mainly concerned to decision support (Cost-benefit analysis, for instance).

Outlook

A set of five workshops taking place at the OECD in Paris (September 2009), the EUCENTRE in Pavia (November 2009, March and May 2010) and the World Bank in Washington D.C. (June 2010) have concluded the SEIM "Road Map" and input into the development of the Request for Proposals (RfP). CEDIM has participated in all of these workshops. The outcome of these workshops is that the Social and Economic Impact engine shall be constructed following a two-track approach: In the first track, the consortium responding to the proposal shall generate a framework for organizing methods for social and economic impact analysis, which will result in a toolbox for quantifying social and economic impacts of earthquake. In the second track, the consortium shall generate methods that will populate the toolbox. In this sense, the main challenge for the consortium awarded with the social and economic impact engine RfP, will be to create a meta-model that is to define rules and processes for the incorporation of all methods for assessing social and economic impacts of earthquakes (Track 1). The consortium will then be asked to contribute to populating such toolbox with their own-generated methods ("core methods").

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GEM – Inventory Data Capture Tool

GEM launched five Risk Requests for Proposals (RfP) at the start of 2010. In cooperation with eleven partners and Google as official collaborators, CEDIM successfully submitted a proposal lead by ImageCat to the Inventory Data Capture Tools Request (RfP). The proposal developed by an international consortia comprising academic institutions from Germany (CEDIM, DLR), USA (ImageCat, OpenGeo, SPA Risk, Stanford Univ.), United Kingdom (ImageCat, CAR, BGS, Univ. Nottingham), Italy (Univ. Pavia), and Switzerland (WAPMERR) was selected. Until April 2013, the international project team will develop an Inventory and Data Capture Tool (IDCT) which allows the generation and collection of the inventory data relevant to the Global Exposure and Global Consequences project teams in GEM. The research scientist at CEDIM (GFZ) will lead the open-source tool development. At CEDIM (KIT) the project partners are in charge of the pilot studies (Padang, Istanbul) which enable to test and report the performance of the developed Inventory Data Capture Tool Set. The project will start in October 2010 with an initial kick-off meeting in the UK organized by the project leaders at ImageCat. More information on the five Global Risk Components of GEM and the selected consortia is available from the GEM webpage (www.globalquakemodel.org).

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Open Source Procedure for Assessment of Loss using Global Earthquake Modeling software (OPAL)

Introduction

The OPAL procedure (Fig. 1) has been developed to provide a framework for optimisation of a global earthquake modelling process, and to provide a state-of-the-art look at what open-source software tools are available globally.

Earthquake Loss Assessments (ELE) are produced in order to detect possible economic, infrastructure and social losses due to an earthquake. In order to produce an effective ELE, four components must be taken into account in that:

*Seismic Loss = Exposure * Vulnerability * Hazard * Damage Loss Conversion*

Where:

- *Exposure* is defined as the amount of human activity located in the zones of seismic hazard as defined by the stock of infrastructure in that location (usually defined by geocell);
- *Vulnerability* is defined as the susceptibility of the infrastructure stock;
- *Hazard* is defined as the probability of a certain ground motion occurring at a location, which can be determined by scenario modelling via stochastic catalogues, PSHA (Probabilistic Seismic Hazard Assessment) or other such methods, and can include different types of earthquake effects;
- *Damage Loss Conversion* can be defined as the mean damage ratio (ratio of replacement and demolition to repair and restoration cost (economically-speaking)), or the social cost (i.e. number of injuries, homeless and deaths).

Aims / Objectives

Because of the myriad of ways that each of these components which make up seismic loss, can be determined, there is a large range of earthquake loss estimation methods available. For some regions one particular method may be more applicable. This is because of a possible reduction in epistemic uncertainty (lack of

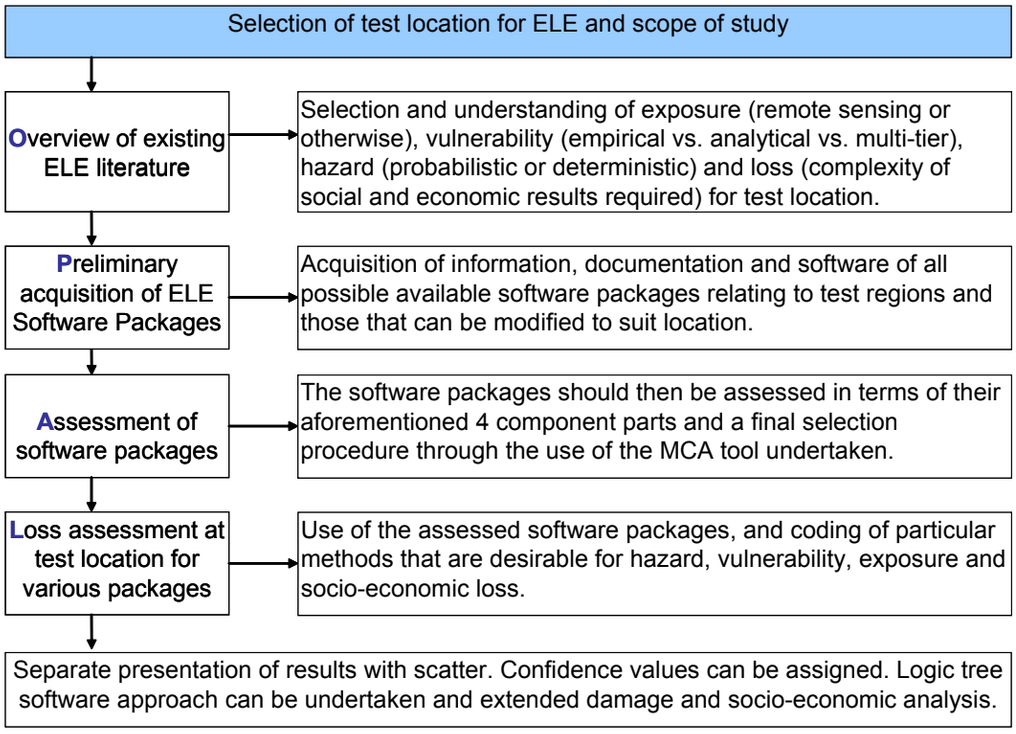

Fig. 1: Flowchart of the generalized OPAL Procedure.

Table 1: A synopsis of the components of 30 mostly used open source worldwide ELE software packages.

ELE Software	Mod.	Region	Owner	Exp.	Haz.	Vuln.	SE.
CAPRA	Ya	Cent. A.	EIRD	Mult.	DP, DO, P	Both	Unk.
CATS		North A.	DTRI, FEMA	Mult.	DP, DO	Emp.	Ec, Sc
DBELA	Yes	World	EUCENTRE	D, Ci	DP, DO, P	Anl.	Ec, Ss
ELER*	Ya	Europe	JRA-3, NERIES	D, Ci	DP, DO, P	Both	Ec, Ss
EmerGeo	Unk.	World	EmerGeo	Mult.	DP	Emp.	Ec, Sc
EPEDAT		North A.	EQE International, California OES	D, Ci	DP, DO, P	Emp.	Ec, Ss
EQRM*	Yes	Aust.	Geoscience Aust	D, Ci	DP, DO	Both	Ec, Ss
EQSIM*	Ya	Europe	KIT, CEDIM	D, Ci	DP, P	Anl.	Sc
Extremum		World	Extreme Situations Res. Ctr. Ltd	Ci, R, Co	DP, DO	Emp.	Ec, Ss
HAZ-Taiwan*		Asia	National Science Council	Mult.	DP, DO	Anl.	Ec, Sc
HAZUS-MH		North A.	FEMA, NIBS	Mult.	DP, DO, P	Anl.	Ec, Sc
InLET*		North A.	ImageCat Inc.	D, Ci	DP, DO	Emp.	Ec, Ss
LNECLOSS		Europe	LNEC	D, Ci	DP	Anl.	Ec, Ss
LOSS-PAGER	Ya	World	USGS	Mult.	DO	Anl.	Ec, Ss
MAEViz*	Yes	North A	Uni. Illinois	D	DP, DO, P	Both	Ec, Sc
OPENRISK	Yes	World	AGORA, USGS, OpenSHA	Mult.	DP, DO, P	Emp.	Ec, Ss
OSRE*	Yes	World	Kyoto U., AGORA	Mult.	DP, DO, P	Emp.	Es
PAGER*		World	USGS, FEMA	Ci, R, Co	DO	Emp.	
QLARM*		World	WAPMERR	Ci, R, Co	DP, DO	Emp.	Ec, Ss
QL2		World	M. Wyss	Ci, R, Co	DP, DO	Emp.	Ec, Ss
RADIUS	Ya	World	Geohazards Int., IDNDR	Ci	DP	Emp.	Ss
REDARS		North A.	MCEER, FHWA	D, Ci, R	DP, DO, P	Emp.	Ec
RiskScape	Ya	Aust.	NIWA, GNS	D, Ci, R	DP, DO	Emp.	Ec, Sc
ROVER-SAT	Ya	North A.	Uni. of Boulder	Mult.	DP, DO	Emp.	
SAFER*		World	23 worldwide institu-tions	D, Ci	DP, DO, P	Both.	Ec, Ss
SELENA*	Ya	World	NORSAR	D, Ci	DP, DO, P	Anl.	Ec, Ss
SES2002 & ESCE-NARIS		Europe	DGPC, Spain	Mult.	DP, P	Emp.	Ec, Ss
SIGE		Europe	OSSN, Italy	Mult.	DP, DO	Emp.	Ec, Ss
SP-BELA**		Europe	EUCENTRE	D	DP, DO, P	Anl.	Ec, Ss
StrucLoss*		Europe	Gebze IT, Turkey	D, Ci	DP, P	Both	Ec, Ss

*those have had a past influence based on HAZUS, ** those on DBELA

Mod =Modifiability, Ya=Yes, but subject to availability, Aust = Australasia, World = Worldwide, North A. = North America, Cent. A. = Central America

Exp =Exposure, D=district, Ci=city, R=regional, Co=Country, Mult.=Multiple levels

Haz =Hazard, DP=deterministic predicted, DO=deterministic observed, P=probabilistic.

Vuln =Vulnerability Type, Anl.=Analytical, Emp.=Empirical

SE =Socio-economic loss, Unk=Unknown as yet, due to pending release of software, Es=simple economic, Ec=complex economic, Ss=simple social, Sc=complex social.

knowledge) due to data collection and scientific assumptions used for the ELE method not being the same at any location in the world. In addition, probabilistic regional uncertainties in source, path and site occur, quantified by aleatory variability. Thus, it is impossible to ever have a 100% accurate seismic loss estimate, and ELEs should quantify this uncertainty (both epistemic and aleatory).

Considerable research has been done to provide adequate earthquake loss estimation models for region specific scenarios and other studies. Many different software packages have been produced around the world in order to provide accurate loss estimates; however, these can be used simultaneously in order to reduce uncertainty in the result. With the wealth of software packages available for these risk assessment studies and economic, social and infrastructure loss estimations, a synopsis of many available packages has been undertaken and a full documentation can be viewed in Daniell (2009).

Project Status

ELE software packages are both closed (proprietary or not freely available but documented) and open-source (freely available or by contacting the developers), and the study first requires a preliminary research, sourcing and familiarization stage with these ELE software packages. These packages are detailed in Table 1 below with a quick synopsis of the applicable region, software availability/modifiability, ownership, vulnerability types examined, complexity of the socio-economic module, exposure level and hazard types examined, which are all needed for the loss assessment process in the Zeytinburnu case study.

The complexity differs significantly between the various software packages and the problem is that most software is not freely available as open source. Thus, although documentation and reproduction of every software package is available, the actual versions are not available in most cases, as seen in the modifiable (mod.) column. Many of these procedures can be changed by the user to add complexity to the social and economic loss outputs.

For Zeytinburnu, Turkey, as a test case, a multicriteria analysis tool was produced in order to aid decision analysis for the 30 reviewed software packages. This uses a number of criteria including the following modules. Each of these has been applied in an easy to use GUI (Graphical User Interface) for people to apply whatever test region they want to code. Depending on complexity within each of the modules, the ranking will change based on the components and information that is available. In some cases, a vulnerability method may be too complex to apply to a certain software package. It also may be that a certain test region has been undertaken that limits the software, or certain hardwiring in the software code is inherent that certain parameters cannot be changed. These 5 modules include:

1. Technical Aspects and Software Detail Module
2. Hazard and Demand Module
3. Vulnerability and Exposure Module
4. Specific Cost Module
5. Rapid Response Use and Technology Module.

It is up to the user to select those software packages that are deemed appropriate for use, and to then critically review using both the user manual and the references to next test the applicability, however a multicriteria analysis tool has also been created to aid this decision. A logic-tree approach is subsequently applied between the software packages in order to achieve a subjective result, as no one system will be correct due to uncertainties in each of the four steps of the Earthquake Loss Estimation procedure, as discussed above. This weighting is based on the quality of the ELE software package. This will minimize outlier results. For insurance purposes, the software package results should be critically reviewed and the variance of the separate models used.

Outlook

Using the OPAL procedure, enough knowledge can be gained to undertake an ELE for a desired test case anywhere in the world. Already, over 10 scientists worldwide have used the procedure to determine suitable software packages, and many more (over 1000) have downloaded the procedure and may be using OPAL. Many ELE software packages have been produced globally from many different institutions, allowing for reasonably accurate damage, social and economic loss estimates of scenario earthquakes to be made. This procedure and information bank will continue to be developed in the future in the hope to encompass a large percentage of the world's open source earthquake loss estimation software packages.

Publication

Daniell, J.E. (2009): "Open source Procedure for Assessment of Loss using Global Earthquake Modelling – OPAL", CEDIM Research Report 09-01.

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Remote Sensing and Population Estimation

Introduction

Population information is publicly available for many countries, but the quality and up-to-dateness of the dataset is sometimes questionable, especially if no metadata are provided. In rapidly growing urban areas, the maintenance of up-to-date population data sets is very time- and cost-intensive. This is especially relevant in the case of India where very large cities, rapid urban development, and very complex urban structures demand new methodologies for population data generation.

In this context, remote sensing, especially optical satellite images, plays a significant role as an independent source of information. Spaceborne remote sensing provides detailed geospatial information at different resolutions and over time periods that could not be obtained before. In combination with a geographic information system (GIS), remotely sensed information can be used to generate valuable input information for urban population estimation. The required input information includes inventory data including built-up area and information on the socio-economic structure of the city. While physical measures related to buildings can be directly calculated from the geometry visible on the space born imagery, socio economic parameters need to be inferred from a combination of physical parameters and secondary information.

Aims / objectives

In this project thesis, a tiered method for population estimation and modeling is developed which integrates information extracted from satellite image and secondary information. This method aims to provide information on the population and its distribution on three spatial tiers: (1) City level, (2) district level, and (3) building level. At each tier, different models are provided for which processing time, input data requirement and associated costs increase with information detail and resolution of the resulting population data. This way, the developed methodology allows for generating population information for large cities without depending on detailed survey information.

The rapidly growing urban agglomeration of Ahmedabad located in the state of Gujarat in Northwest India is selected as the test site for the methodology development. The city of Ahmedabad is an example of a dynamic metropolis with a population of approximately 3.5 million in 2001 and an annual population growth rate of 2.4%. In terms of urban growth, the areal extent of Ahmedabad increased by 46.72% between 1972 and 2000 (see Fig. 1).

A methodology is developed to spatially model the population of the Ahmedabad Municipal Cooperation (AMC) area using satellite images and census data. At city level (tier 1), three models were developed to estimate the population within the AMC area and within the urban extent of the AMC area. The extent of the urban areas was extracted from moderate optical satellite images (Landsat 5 TM) and very high resolution optical satellite images (Quickbird). The city population for 2008 was projected to be 3,152,108 people, with a population density of 23,091 people/km² in the AMC area (model I). For the urban population (model II), the population density was estimated 56,791 people/km² for the Quickbird image and 34,446 people/km² for the Landsat image. The density difference is due to the fact that the urban extent extracted from Landsat is larger than the urban extent extracted from Quickbird because of mixed pixels (see Fig. 2). Model III allows for population estimation and for modeling the spatial distribution of the population for different times of day. In this study, two occupancy–based approaches were tested: A binary approach which distinguishes only residential and non-residential occupancy (Coburn &

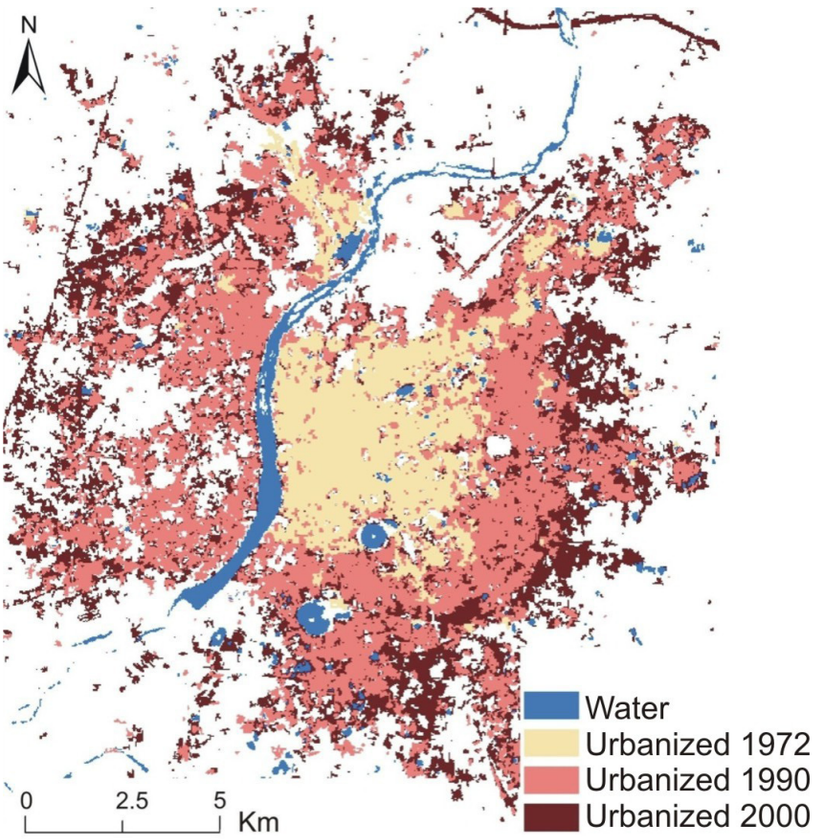

Fig. 1: Urban growth of Ahmedabad. The urbanized area has been extracted by Taubenböck et al. (2009). Between 1972 and 2000 the urban area of Ahmedabad increased by 46.72 % from 29.11 km² to 159.81 km².

Spence, 2002) and an approach provided by HAZUS using 4 different occupancy categories (FEMA, 2008). Tier 2 operates on district level and provides 3 different models to estimate and model the population. The first model (model IV) provides the district population as an aggregated value for the administrative boundary. The second model (model V) calculates the population in the urban areas within each district. The results from model IV and V revealed that the district population varies considerably in the AMC area. The districts with the highest population are located in the south-eastern periphery of the AMC area. However, the districts with the highest population density are located in the central part of the AMC area due to the much smaller administrative area (see Fig. 3). This shows that the assumption of a constant population density which proved to be valid on city level cannot be readily transferred to district level. At tier 3 - building level, two models were developed to estimate the population and model the population distribution within the districts. Model VII estimates the population on building block level, the second model VIII operates on single building level. Because of limited data availability, only the building block model was tested for the city of Ahmedabad.

Project Status

In autumn 2008, CEDIM and ImageCat initiated a cooperation research project to develop a methodology which utilizes remote sensing and GIS data to meet the requirement for basic socio-economic inventory data for a range of applications in the field of earthquake disaster management. In the framework of this project, Eike – Marie Nolte finalized her PhD on “The applications of optical satellite imagery and census data for urban population estimation: A case study of Ahmedabad, India” in July 2010.

Outlook

Methodologies developed and results obtained in the context of this research project will be employed in the GEM project “Inventory Data

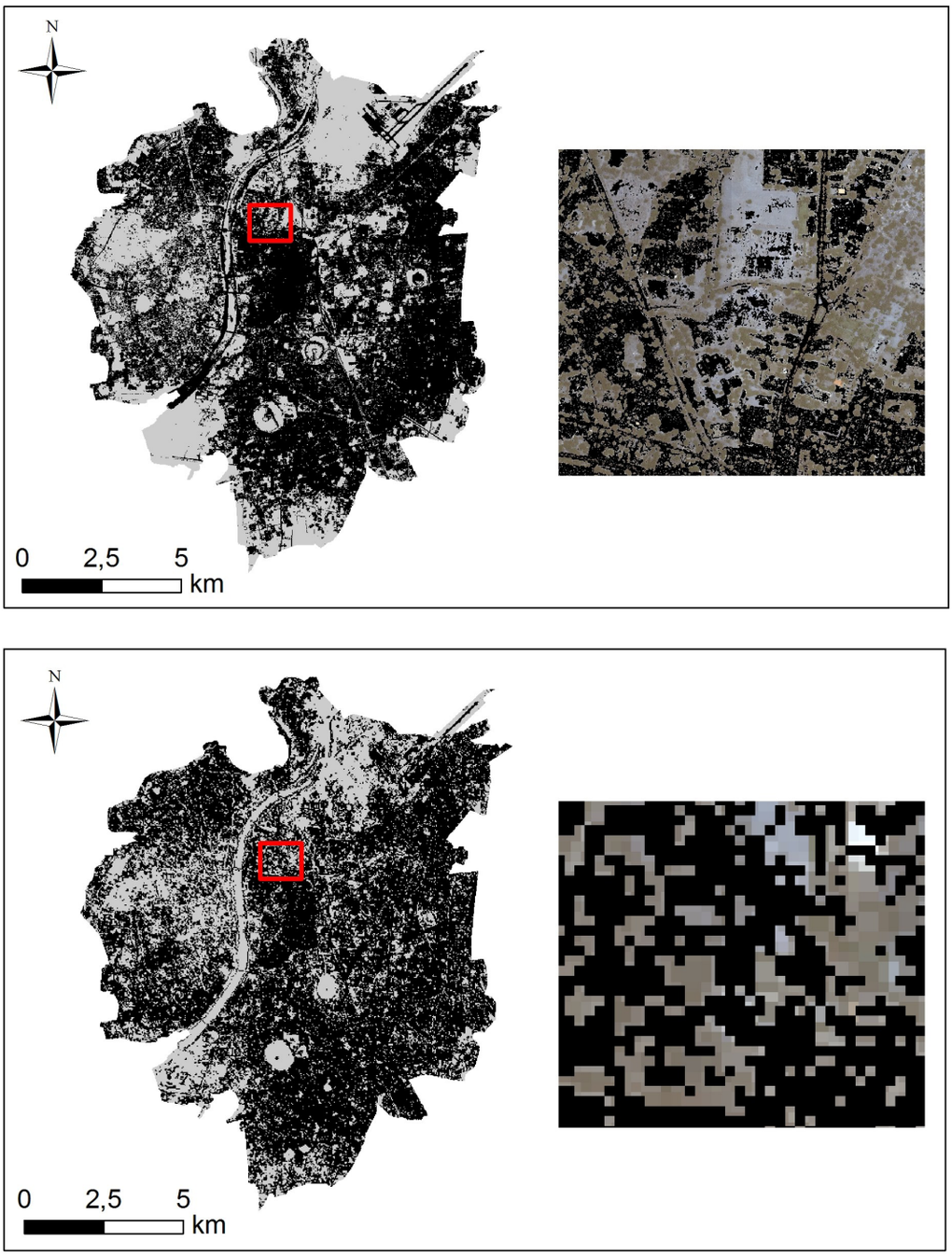

Fig. 2: Built-up areas extracted from satellite images for the AMC area: (Upper figure) Quickbird image and (lower figure) Landsat image.

Capture Tool" (see above this report). The continuation of population distribution works in Ahmedabad is currently not intended.

Publications

Nolte, E.: Anwendungsmöglichkeiten optischer Satellitenbilder und Zensusdaten zur Bevölkerungsmodellierung am Beispiel der indischen Stadt Ahmedabad. Hochschulnachrichten. Photogrammetrie – Fernerkundung – Geoinformation 6/10. 2010 (accepted).

Nolte, E., Adams, B.J., Wenzel, F. (2010): Population Estimation for Megacities: Solving Disaster Management Challenges Using Remote

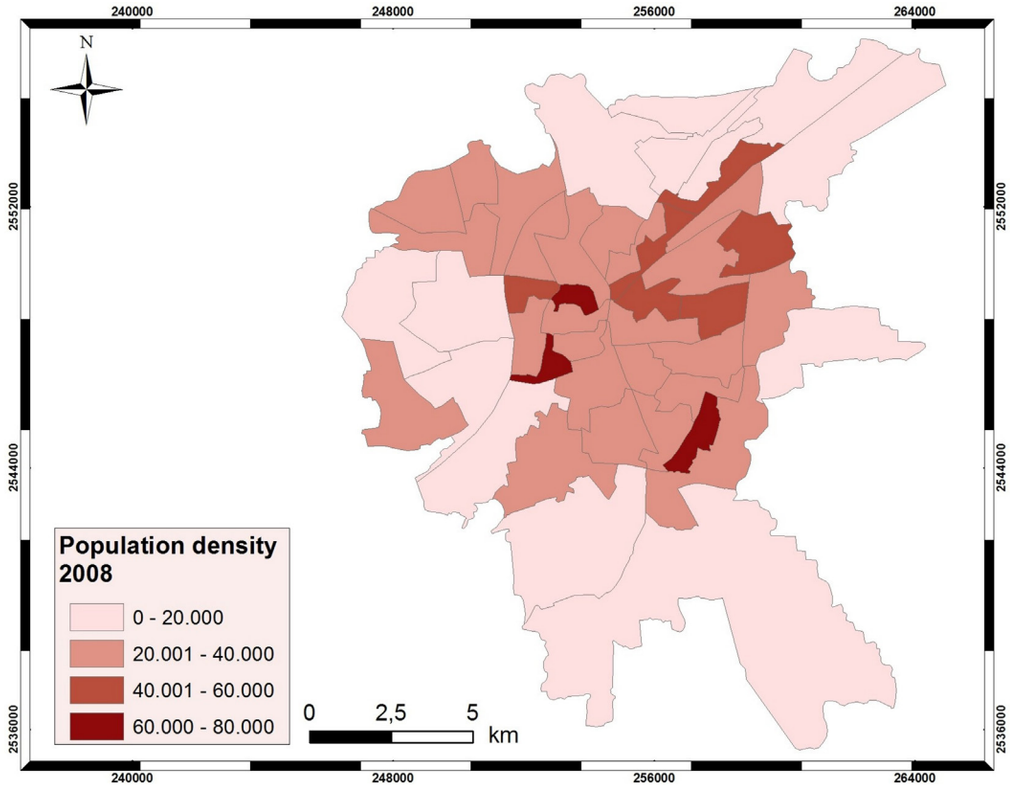

Fig. 3: District level population density map.

Sensing, Web-GIS and Advanced Technologies. In: O. Altan, R. Backhaus, P. Boccardo, S. Zlatanova (eds): Geoinformation for Disaster and Risk Management - Examples and Best Practices Joint Board of Geospatial Information Societies (JB GIS) Copenhagen, Denmark. (available for download http://www.isprs.org/documents/announcements.aspx).

Nolte, E.(2010): The application of optical satellite imagery and census data for urban population estimation: A case study for Ahmedabad, India. Diss. Fakultät für Bauingenieur-, Umwelt- und Geowissenschaften, Karlsruher Institut für Technologie, SVH Verlag, Saarbrücken,(accepted).

Nolte, E.(2010): The application of optical satellite imagery and census data for urban population estimation: A case study for Ahmedabad, India. Diss. Fakultät für Bauingenieur-, Umwelt- und Geowissenschaften, Karlsruher Institut für Technologie, Online-Ressource (english), (available for download http://digbib.ubka.uni-karlsruhe.de/volltexte/1000019361).

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United Nations - World Population Prospects: The 2008 Revision. Working Paper No. ESA/P/WP 210. United Nations, Department of Economic and Social Affairs, Population Division, 2009.

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Vulnerability and Critical Infrastructures

KRITIS

Basic concept of an integrated decision support system for disasters with affected critical infrastructures (KRITISKONZ)

Introduction

Project Duration: June 2010 – December 2010

Critical infrastructures (CI) such as energy supply, the supply of drinking water and food, telecommunications, information technologies and transport systems are necessary for the functioning of a modern society. However, due to their complexity CIs are highly vulnerable to disturbances such as extreme weather events or terrorist attacks. Because of interdependencies between the CIs, disruptions can be propagated via cascading effect which leads to a spatial as well as temporal enhancement of the impacts of a CI disruption. Accordingly a spatial-temporal development is reflected by the impacts. Therefore the knowledge and the simulation of interdependencies is a key element for a successful crisis management. Thus there is a high interest of authorities and industry regarding decision support systems for emergency situations.

Aims / Objectives

The main objective of the project is the development of a conceptual framework for a decision support system which assists decision-makers at various levels and scales in the field of CIs. The focal point of the system is the analysis of the interdependencies between infrastructures, the simulation of the impacts on other critical infrastructures, population and economy as well as the evaluation of the effectiveness of different countermeasures.The objectives are:

- Pooling the competencies at KIT in the area of decision support for critical infrastructure incidents
- Developing an integrated system approach for decision support for critical infrastructure incidents and identification of methodological challenges
- Consideration of recommendations that were made in the evaluation of the LUEKEX exercise
- Presentation of possible solutions for the construction of an integrated system approach and the required research
- Preparation of a detailed concept for further efforts within CEDIM to realize the integrated system approach

A meeting with CEDIM partners from Karlsruhe and Potsdam, the cedim AG, the Fraunhofer Institute of Optronics, System Technologies and Image Exploitation (IOSB), the University of Wuppertal and the Federal Office for Civil Protection and Disaster Assistance (BBK) was held to define user requirements for a decision support system and to discuss the modeling strategy. Based on the meeting an initial document describing possible components and functions of the decision support system was elaborated. In this context the requirements between simulation and decision support are distinguished.

The requirements differ considerably among the tactical-operational and strategic simulation. However, some general statements can be made:

- Strategic Simulations should provide information about the development of a situation at an upper level with and without the implementation of countermeasures
- Strategic Simulations are intended to provide information about the interdependencies of CIs, the potential countermeasures and finally whether the resources are appropriate for the selected countermeasures
- Operational-tactical simulations are intended to provide information on process level about the countermeasures. The details are constrained by the situation and the affected CI.

Concerning the requirements for decision support, the user expects a system that is assisting, but not carrying out decisions. Therefore automated solutions are only suitable for previously defined functions and should be adaptable by the users. These solutions are especially used to filter out inadequate options or warn users. In addition, the system should automatically indicate when the resource allocation exceeds

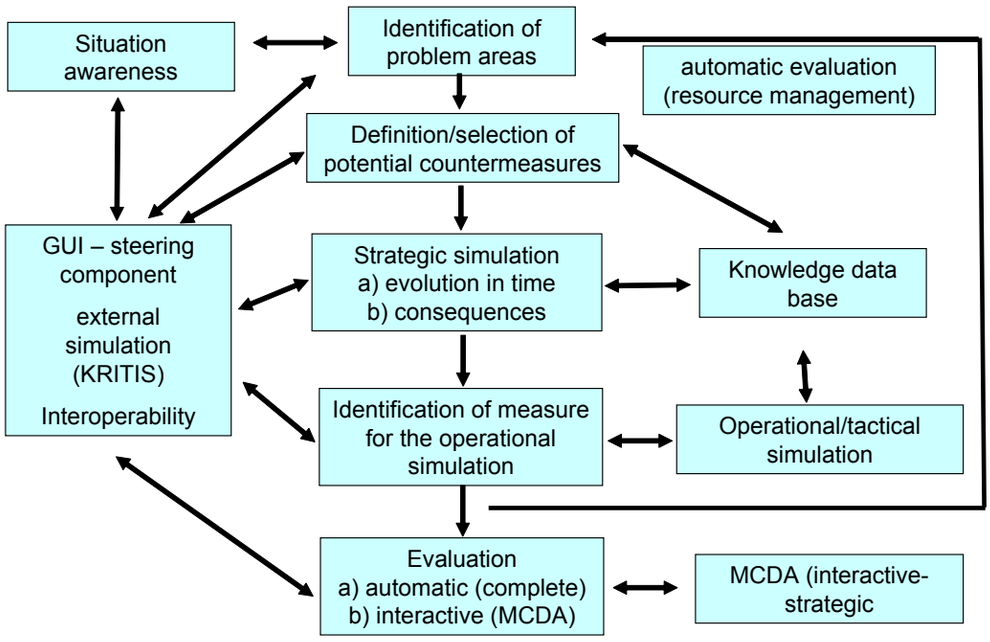

Fig. 1: Structure of the decision support system.

the resource availability. Interactive solutions are required only for long-term incidents. In the response phase decision support should be mainly focused on an appropriate visualization of the situation and on forecasting simulations.

Project Status

The project will be completed by the end of 2010. The developed concept will be implemented during the ensuing period.

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Natural Disasters and Transportation

Introduction

Transportation networks, especially road networks, are of great importance to many private and commercial activities. What happens if crucial parts of a road network are suddenly unavailable due to, for example, natural disasters has been experienced many times in the past. In 2006, for example, a rockslide at the Gotthard-Tunnel killed several people and the road was closed for days in both directions. The Alp transit traffic consequently congested the alternative route and generated additional emissions and delays. The society's dependence on a reliable transportation network increases its vulnerability. To keep potential losses low, it is therefore essential to detect critical vulnerable links and identify risk minimizing measures. The EU Commission also acknowledged this need in its Directive 9403/08 „On the identification and designation of European Critical Infrastructure and the assessment of the need to improve their protection". The directive requires all member states to identify and report on their critical transportation infrastructures until January 2011.

Aims / Objectives

The aim of the project is to develop a methodology for the quantification of indirect losses caused by a road closure and the identification of road sections, where these losses are extremely high. Indirect losses are entailed by direct damages (like e.g. a collapse of a bridge) and comprise, for example, costs for detouring the disrupted link.

Baden-Wuerttemberg's road network serves as a case study. Each individual link of motorways and federal roads is successively removed and the additional costs of road users due to the withdrawal are calculated via transport modelling. The costs include monetized time, environmental and operational costs differentiated by trip purpose. The calculations vary depending on the duration of the interruption. If the disruption of a network element is short-term, people are likely to stick to their original trip destinations but vary their routes. In the long run, however, road users may also decide to change their travel mode or trip destination.

The monetary valuation of time or emissions is often criticised for its subjectivity and strong influence on the results. Therefore a sensitivity analysis on the value of time a major part of the indirect costs (see Fig.1) will be carried out to identify network sections that are robust against the valuation methodology.

In cooperation with the PTV AG the transport model VALIDATE implemented in the software VISUM serves as modelling background. A self estimated logit-based model is also needed in order to differentiate losses in various timescales.

Exemplary calculations (see Fig.1) showed that the simultaneous interruption of different network sections may entail losses of a scale nonlinear to the losses of an individual disruption. A multi-section closure can be considered as a likely consequence of an extreme natural event. These two aspects are captured in two scenarios assessing the indirect losses. One scenario is based on the preliminary works on earthquakes and transport infrastructure together with the Institut für Massivbau und Baustofftechnologie at the KIT and simulates an earthquake similar to the one that happened 1911 in Ebingen. This earthquake would not entail a total collapse of a bridge or tunnel but would rather cause the temporary closure of structures for inspections. Another scenario is based on the indirect losses caused by a flood with a dike failure of the Neckar close to Esslingen. The scenario is based on calculations of the Institut für Wasser und Gewässerentwicklung Bereich Wasserwirtschaft und Kulturtechnik at the KIT.

Project Status

Literature research and the development of the methodology for calculating the indirect losses are completed. The transport model has been adjusted to the purpose of the study. A logit model for calculating the middle-term losses due to destination choice changes has been estimated. The programming code has mostly been implemented. The necessary data for the scenarios is available. Some calculations, the sensitivity analysis and their documentation are still outstanding.

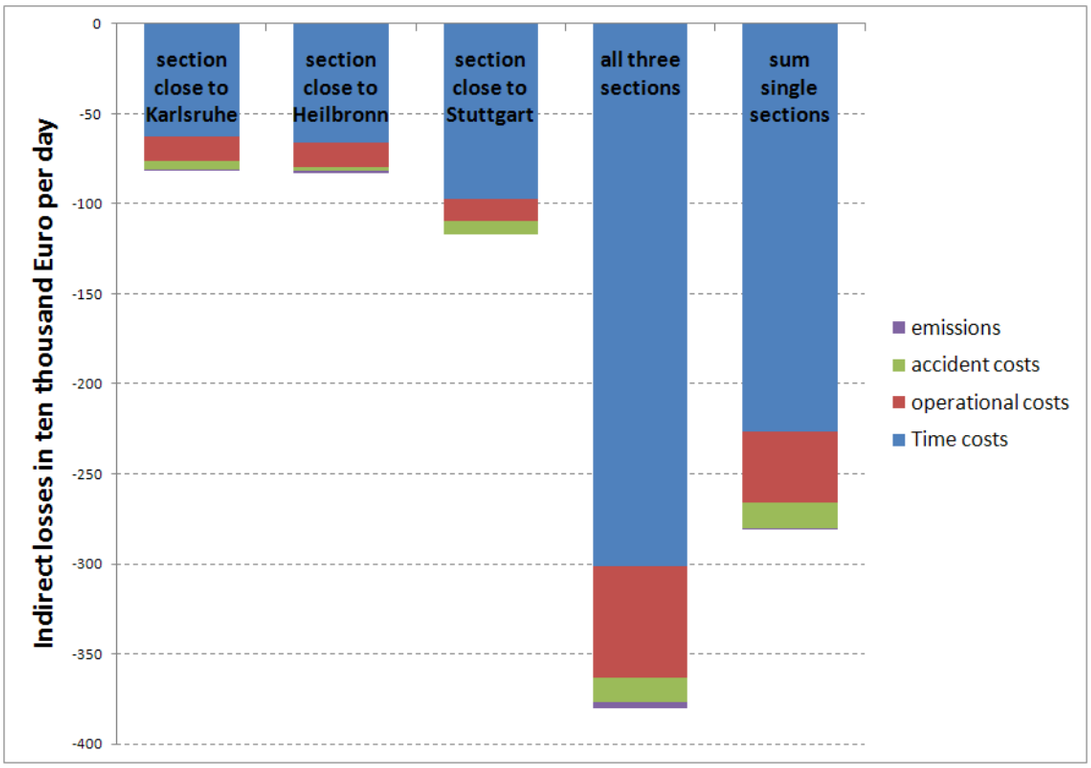

Fig. 1: Exemplary calculation of indirect losses at the case of 3 different closures of motorway sections close to Karlsruhe, Heilbronn and Stuttgart, a simultaneous closure of all three sections and the sum of the single closures. The results demonstrate the major part of time costs compared to other cost components. It also shows the higher costs of a simultaneous closure compared to the sum of costs of single closures.

Outlook

All activities are scheduled to be finalized at the beginning of 2011. Everything will be documented in form of a PhD thesis. Further publications on certain aspects of the thesis are planned.

Publications

Lueders, S., Schulz, C. (2010): Auswirkung von Naturkatastrophen auf das Verkehrsverhalten. Working Documents of Freight Transport and Logistics. No. 4. http://digbib.ubka.uni-karlsruhe.de/volltexte/1000020058. urn:nbn:de:swb:90-200580.

Schulz, C., Khazai, B. (2008): An indicator-based approach for critical road infrastructure identification, Conference abstract, IDRC 2008, 25.-29.08.2008 in Davos, Switzerland.

Schulz, C. (2009): The identification of critical road infrastructures - The case of Baden -Württemberg, Konferenzbeitrag beim Winterseminar der Gesellschaft für Regionalforschung, 22.-28.02.2009, Innsbruck, Österrreich.

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WEATHER

Weather Extremes: Impacts on Transport Systems and Hazards for European Regions

Introduction

Project Duration: November 2009 - April 2012.

The WEATHER project aims to analyze the economic costs of extreme weather events on transport and the economy by considering adaptation strategies in the context of sustainable policy design. The research is carried out by an international team of eight European institutes, coordinated by the Fraunhofer-Institute for Systems and Innovation Research (ISI), Karlsruhe. WEATHER is funded under the Seventh Framework Programme (FP 7) of the European Commission.

Project partners:

- Agenzia regionale per la Prevenzione e l'Ambiente dell'Emilia Romagna (ARPA-ER), Italy
- Centre for Research and Technology Hellas - Hellenic Institute for Transportation (CERTH-HIT), Greece
- Fraunhofer-Institute for Systems and Innovation Research (ISI), Germany
- Fraunhofer-Institute for Transportation and
- Infrastructure Systems (IVI), Germany
- Herry Consult GmbH, Austria
- Institute of Studies for the Integration of Systems (ISIS), Italy
- NEA Transport research and training, The Netherlands
- Société de Mathématiques Appliquées et de Sciences Humaines -International Research Center on Environment and Development (SMASH-CIRED), France

Every year extreme weather events cause large economic losses in the European Union. In particular, transport systems show a high degree of vulnerability. For instance in 2010 the winter storm "Xynthia" led to large-scale restrictions on road and rail traffic throughout Europe.

Various actors such as reinsurance companies, operators of transport infrastructures and public authorities are strongly interested in assessing the impact of weather extremes on the transport sector and the related direct and indirect costs. A cost-benefit analysis of adaptation measures is essential to select the most suitable measures.

In the course of global climate change the frequency, occurrence and strength of certain forms of extreme weather events are expected to vary. In southern Germany for example a significant increase of convective precipitation in summer is expected for the period of 2011 to 2040 (Climate Change in Baden-Wuerttemberg, 2010). The local and unpredictable convective precipitation events can have severe direct and indirect effects on the different modes of transport. In rail transport, direct damage can be inflicted upon critical infrastructure elements, e.g. due to inundation or undercutting of railway tracks or lightning strikes in signal and switch systems (Tab. 1). Roads can be blocked by land slides or inundation. The indirect consequences of extreme weather events are disturbances in the processes/procedures of various modes of transport, in particular in the form of delays, closures and detouring.

Considering the interrelationship between possible impacts of extreme weather events and the transport sector, at least three parameters can be identified. Thus, the severity of direct and indirect effects depends on time (season, time of day event duration), regional conditions (topography, socio-economic structure, hazards, climate type) and the affected traffic structure (mode, actors, demand, systemic importance, vulnerability, resilience).

A strategy to reduce the direct and indirect damage potential is the implementation of appropriate adaptation measures to cope with the changes in extreme weather conditions. In this respect adaptation can aim at infrastructure elements (such as installation of lightning protection devices for signalling systems and points or increasing the capacity of the drainage system) and/or processes/procedures (such as shortening the inspection and maintenance intervals for track bed and track).

However, not every adaptation measure can be carried out at all time and must also be assessed with regard to the regional conditions and traffic structure. In particular there is a di-

rect interrelationship between the planned adaptation measures and the traffic structure. On the one hand, the existing traffic structure sets the framework for a specific package of measures and on the other hand, an implemented adaptation measure can itself affect the traffic structure. For instance, the shortening of the inspection and maintenance intervals of the track ballast (track bed and track) can have negative consequences for service provision (such as schedules and punctuality) and thus for the demand.

Appropriate adaptation measures contribute to the reduction of vulnerability as well as to the increase of resilience of a transport mode. But at the same time additional costs can occur. In this context, one should consider as fundamental and simple premise that the negative effect of adaptation on the direct and indirect damage potential should not be less than the cost of the measure employed.

Table 1: Direct effects of extreme weather events on rail transport.

Rail transport	**Winter storm and storm**	**Heavy snowfall**	**Convective precipitation**
	fallen trees	snow breakage snowbank	lightning inundation/scouring land slide
Overhead contact line	Damaging	Damaging	
Tracks	Damaging	Damaging	Damaging
Track bed	Blockage	Blockage	Damaging
Signalling systems	Damaging	Damaging	Malfunction/Breakdown
Points	Malfunction/Breakdown	Malfunction/Breakdown	Malfunction/Breakdown
Other electrical systems	Malfunction/Breakdown	Malfunction/Breakdown	Malfunction/Breakdown
Railway vehicles	Malfunction/Breakdown		Derailing
Railway buildings	Derailing		Damaging
Underbridges			Blockage
Bridges			Damaging
Platform		Blockage	Blockage
Dimension	regional	regional	local
Season	Autumn/Winter/Spring	Winter	Spring/Summer
Trend	increasing	declining	increasing
Predictability	good	good	poor
Adaptation	exacerbate tree-cutting strategy	Heating system for	increase the capacity of the drainage system
	adjust forest management	electrical systems	shorten the inspection and maintenance intervals for track ballast
		increase of winter service capabilities	identification/safeguarding of vulnerable track sections
			installation of lightning protection devices

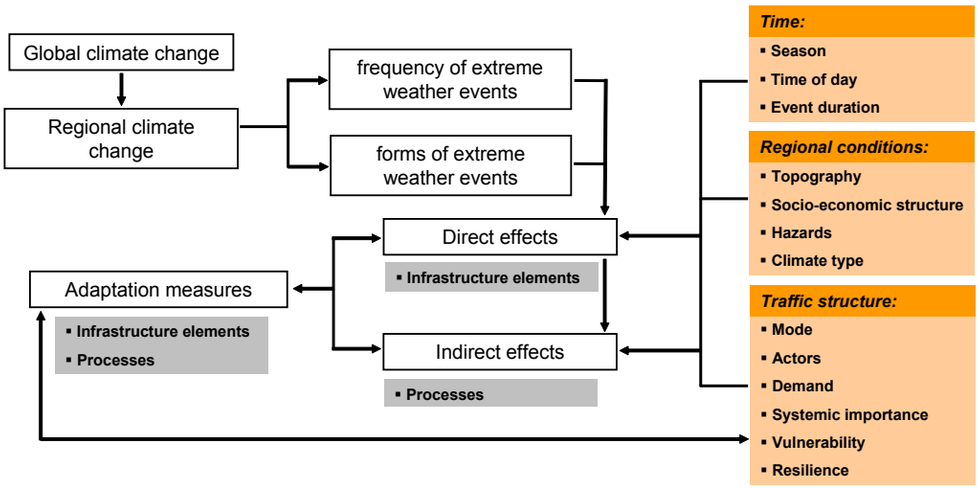

Fig. 1: Interrelationship between impacts of extreme weather events and transport.

Project Status

On September 14th, 2010 - a first workshop on the topic of „Transport Sector Vulnerability“ was held in Brussels. The forthcoming work packages will work intensively on „Crisis management and emergency strategies“ and „Adaptation options and strategies“.

Publications

Trinks, Ch., Hiete, M., Schultmann, F. (2010): Auswirkungen extremer Wetterereignisse auf die Transportsysteme in europäischen Regionen, DACH Meteorologentagung 2010, Bonn 20.9. - 24.9.2010.

Core Science Team

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Working Group „Analysis of indirect vulnerability of natural disasters"

Introduction

Vulnerability represents the intrinsic side of risk. Due to the importance of indirect disaster losses, within an integrated risk analysis, not only the physical vulnerability of buildings and infrastructure elements but also the vulnerability of society and industry to indirect disaster impacts should be considered. Social vulnerability is increased by the lack of political, institutional and economic potentials. The vulnerability of industrial production systems to indirect loss (e.g. due to business disruptions) is influenced by various different sector-specific fragility and resilience factors. This, for example, includes properties, which increase or decrease the dependency of the industry on manufacturing equipment, human work force, infrastructure systems and supply chain processes.

Aims / Objectives

Aim of the project is the development of an integrated indicator model to analyze the industrial and social vulnerability to indirect disaster losses. Given the complexity of the regional vulnerability an integrated indicator system is particularly suitable, as vulnerabilities of different subsystems (industry and society) and different levels of observation (regional and sector level) can be combined. Furthermore, indicator based approaches can be extended easily. This allows, for example, the future integration of other sub-systems (e.g. agriculture, ecology). Regarding the dynamic changes in vulnerability due to climate change, the indicator model gives the possibility to take future changes of single factors and forecast data into account in order to gain results on the future vulnerability of the sub-systems (e.g. projection of future population growth trends and their spatial extent).

The developed indicator model is applied for the assessment of the indirect regional vulnerability of different districts (Landkreise) in Baden-Wuerttemberg. Baden-Württemberg has been selected as case study area due to its economic significance and the given data availability (especially for the industrial sector).

Within the development of the integrated indicator model, for both subsystems (social and industrial) fragility and resilience factors were identified in a first step (see Fig. 1). While fragility factors enhance the vulnerability of a system, resilience factors describe the coping capacities of a system which leads to a reduced vulnerability.

For the social vulnerability, the vulnerability factors have been identified on a regional level. The social vulnerability indicators have been structured hierarchically and the indicator values have been quantified using official statistical data. For the assessment of the industrial vulnerability a hierarchical indicator model was developed, which can be used to analyze the vulnerability of different industrial sectors. Within the hierarchical indicator model various fragility factors (e.g. specific power consumption, degree of economic integration, degree of specialization of the employees) and resilience factors (end customer distance, degree of self-supplying in electricity) are considered.

For both sub-systems the single indicators have been combined into a composite index using methods from the field of Multi-Criteria-Decision-Analysis (MCDA). The social indicators are aggregated into a Social Vulnerability Index (SVIR) and the industrial indicators are combined into an Industrial Vulnerability Index (IVIs). For the aggregation of the single indicators into composite indicators the linear aggregation method has been used. Before the aggregation step the indicator values have been normalized and weights, representing the importance of each indicator, have been elicited.

Within the integrated indicator framework the social and industrial vulnerability are combined on a regional level. Therefore, in order to determine the regional industrial vulnerability (IVIR) based on the sector-specific vulnerability indices (IVIs) (see Fig. 2) a regionalization method has been developed. The regionalization method enables the distribution of the sector-specific results to a spatial level according to industrial structure and the industrial exposure (industrial density) of a region.

In order to unite the social and industrial vulnerability in an integrated model, both sub-indices (SVR und IVIR) have been combined again by the use of a multi-criteria method. As within a hierarchical indicator model, due to the aggre-

gation into one overall index, dependencies between the indicators may lead to an over- or underestimation of single vulnerability dimensions, within the development of the model the DEMATEL (Decision Making Trial and Evaluation Laboratory) has been adapted to analyze the dependencies between indicators. For the integration of the structural relationships among the indicators, the results of the DEMATEL-analysis were used to calculate correction factors for indicator weights. The correction factors have been used within the aggregation step to modify the indicator weights and to correct the vulnerability results for inter-indicator dependencies. The calculated total vulnerability (Regional Vulnerability, RVR) as well as the SVIR and the IVIR are depicted in Figure 2.

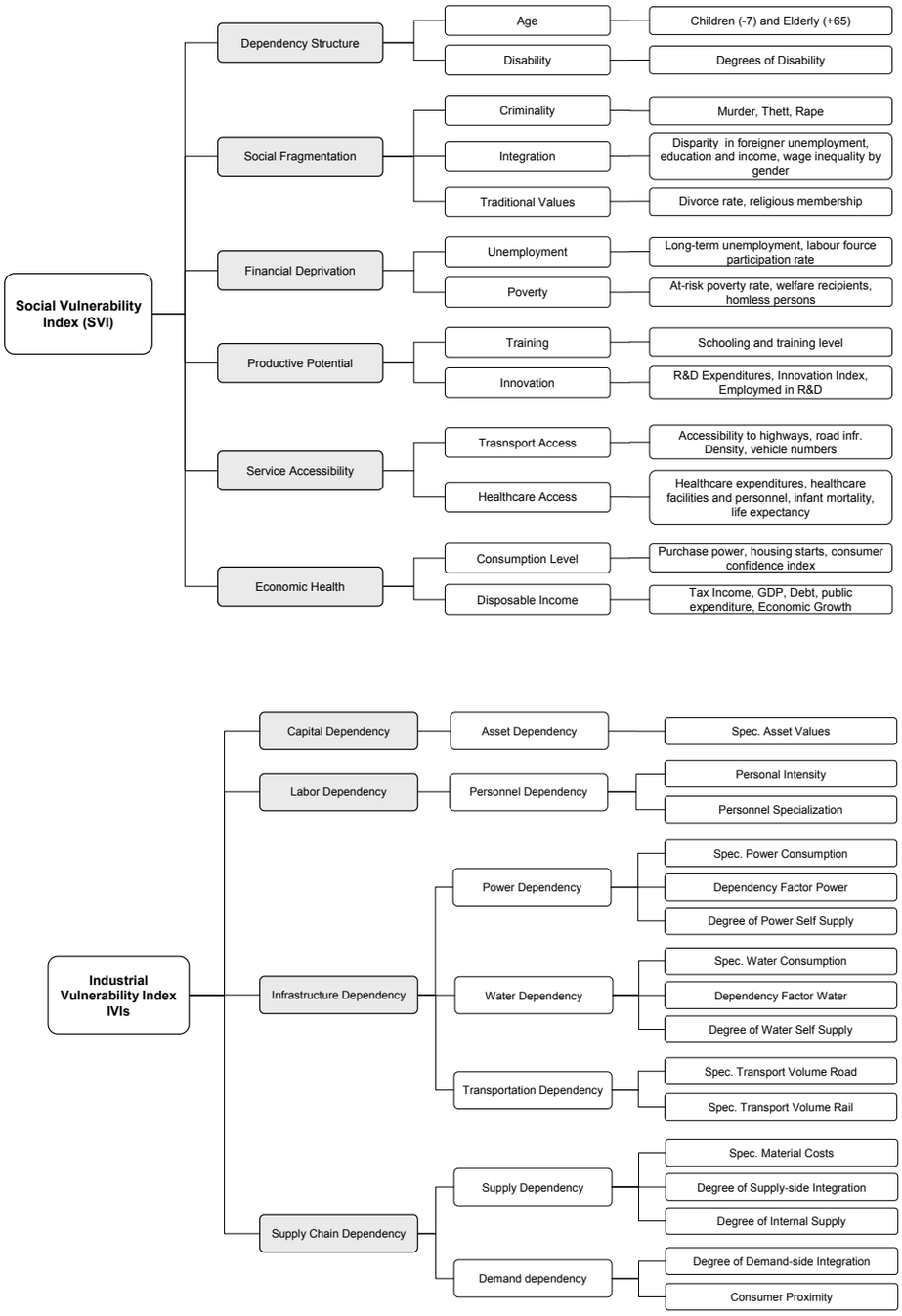

Fig.1: Social and industrial vulnerability: indicator model.

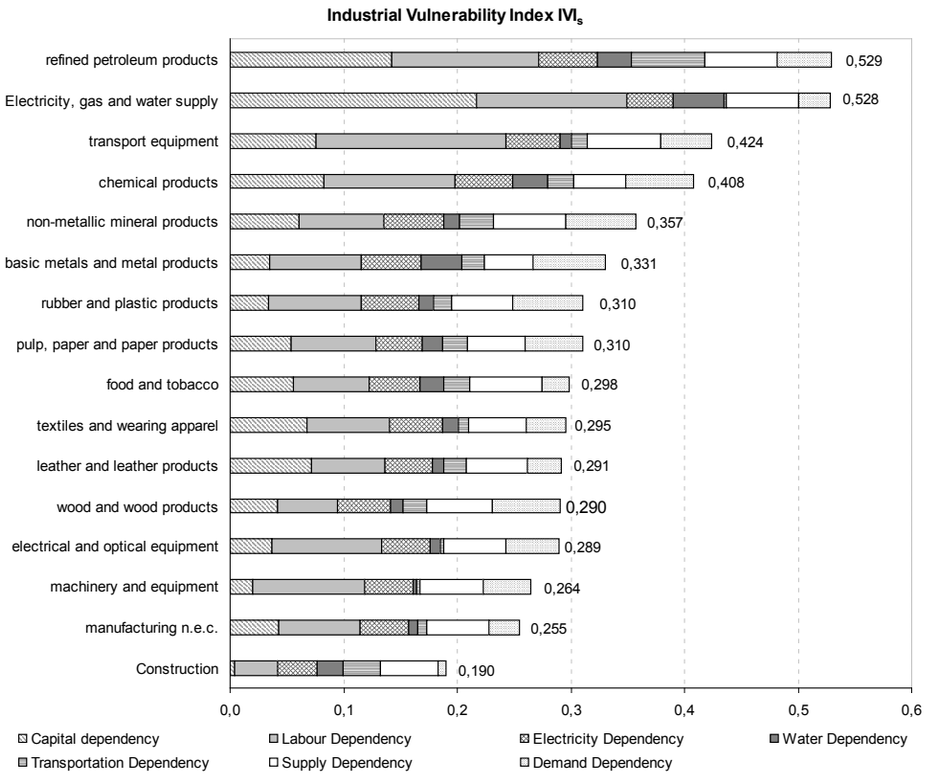

Fig. 2: Indirect disaster vulnerability of industrial sectors.

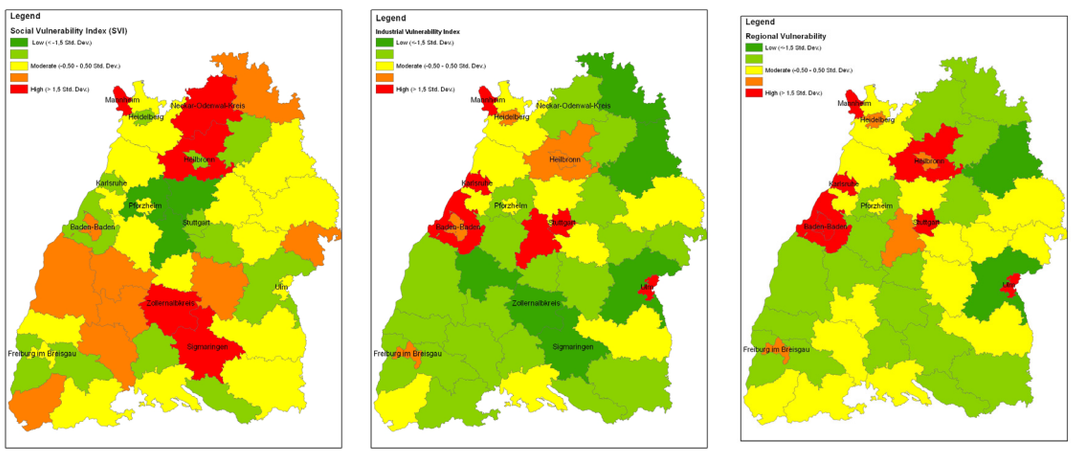

Fig.3: Social Vulnerability Index (left), Industrial Vulnerability Index (middle), regional vulnerability (right) in Baden-Württemberg (district level), green: low, yellow: moderate, red: high.

Project status

The development of the integrated indicator model has been completed and the indirect vulnerability of the districts (Landkreise) in Baden-Wuerttemberg has been assessed. A publication referring to the development of the indicator model and the results of the vulnerability analysis in Baden-Württemberg will be finished by the end of 2010.

Outlook

It is planned to link the results of the vulnerability analysis with the regional hazard analysis (earthquake hazard) in order to determine the indirect earthquake risk in Baden-Wuerttemberg on the district level. Furthermore the integrated indicator model should be modified for the analysis of the indirect vulnerability to hail in order to be integrated into the regional assessment of hail risk. The industrial vulnerability model will be documented in a PhD thesis by the end of 2010 (M.Merz).

Publications

Khazai, B., Merz, M., Schulz, C., Borst, D. (2010): An Indicator Framework to Compare Regional Vulnerability in Society and Industrial Sectors to Indirect Damage from Disasters, submitted.

Merz, M., Hiete, M., Schultmann, F. (2010): An indicator framework for the assessment of the indirect disaster vulnerability of industrial production systems Proceedings IDRC 2019, 29.05.-03.06.2008, Davos, Switzerland.

Merz, M., Hiete, M., Schultmann, F. (2010): Entwicklung eines Indikatorenmodells zur Ermittlung der indirekten industriellen Vulnerabilität, Poster at the 10th Forum Disaster prevention.

Hiete, M., Merz, M. und Schultmann, F. (2010): A trapezoidal Fuzzy DEMATEL-approach for the assessment of the dependencies among different sub-indicators of a hierarchical indicator model, EURO, Lisbon.

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SYNER-G

Systemic Seismic Vulnerability and Risk Analysis for Buildings, Lifeline Networks and Infrastructure Safety Gain

Introduction

The SYNER-G research project (http://www.vce.at/SYNER-G/index.htm) was approved in November 2009 by the European Commission in the framework of its Environment Programme – Call FP7-ENV-2009-1. The overall objective of SYNER-G is to increase the understanding of the vulnerability of various societal elements at risk belonging to a system (city, region, lifeline network, etc.) and establish a European reference for seismic societal and physical vulnerability. In particular, SYNER-G aims to further develop appropriate fragility relationships for the vulnerability analysis and loss estimation of all elements at risk, for buildings, building aggregates, utility networks (water, waste water, energy, gas), transportation systems (road, railways, harbors) as well as critical facilities such as hospitals. The main contribution of SYNER-G is the development of a systemic framework and methodology which accounts for *intra-relations* between the components of each system, and *inter-relations* between the systems making up the infrastructure. The aim is the formulation of a system function that allows the evaluation of the state of the system as a function of the states of its components. The availability of such a function is a prerequisite for the evaluation of the system performance. Ultimately, the goal is to implement the methodology in an appropriate open source and unrestricted access software tool.

Aims / Objectives

Within the SYNER-G project, CEDIM is leading the work package on socio-economic loss and vulnerability (WP4). The overall objective of this work package is to transfer the interdependencies and consequences of losses in physical systems (buildings, utility and transportation network components, critical facilities) to their consequences on society and economy as measurable indicators and values of socio-economic losses upon which policy and decision-making can take place. Metrics that describe direct social consequences; such as number of casualties, number of displaced people, emergency shelter needs, demand on healthcare systems and other critical facilities are key inputs for emergency response planning and preparedness. Furthermore, non-availability of lifeline networks (roads, pipelines, electricity and water supply) have important consequences on the recovery process and contribute to increased social disruptions. Poor linkages between damage to physical systems and resultant social consequences remain a significant limitation with existing hazard loss estimation models. A new direction being explored in SYNER-G WP4 is the inclusion of social vulnerability (often limited to conceptual frameworks) into the modeling approaches used by engineers. Emphasis in SYNER-G is placed on the early emergency relief and recovery period where the rapid provisioning of food, water, shelter and emergency healthcare services are the most important interventions to keep people alive and safe. Thus, the socio-economic vulnerability and losses in SYNER-G will be primarily focused in analyzing the performance of two sectors: temporary public shelter and emergency healthcare services. The socio-economic model will be implemented and tested in L'Aquila and Thessaloniki.

In addition to WP4, research scientists at CEDIM are involved in exploring the potential of vulnerability assessment by optical satellite imagery under another activity of SYNER-G. Here the aim is a review and synthesis of the most applicable methodologies for extracting parameters used in vulnerability analysis in Europe.

Project Status

In considering socio-economic vulnerability and losses in SYNER-G a new methodology is proposed to better describe direct socio-economic impacts from earthquakes such as outdoor deaths, injuries and shelter needs based on populations seeking public shelter. Figure 1 shows three possible entry points for socio-economic models. In SYNER-G the socio-economic models will be brought in at the second entry point depicted in Figure 1. Here, new methods will be developed to compute social losses (e.g., number of displaced people seeking public shelter) as an integrated function of hazard intensity, vulnerability of physi-

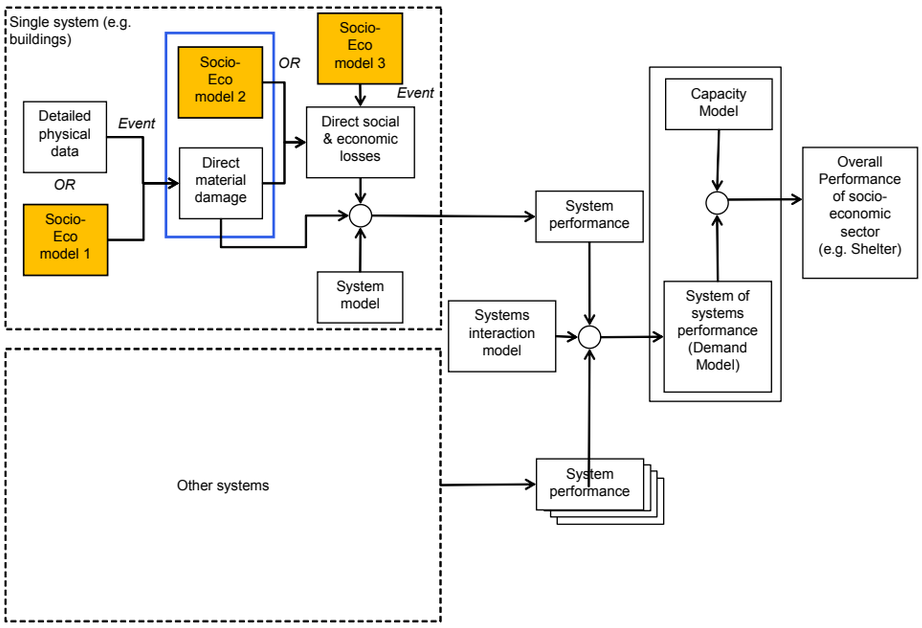

Fig. 1: Possible interaction of socio-economic models with physical vulnerability/loss estimation models.

cal systems (based on "fragility curves") and the social vulnerability of the population at risk through the development of a set of "social vulnerability functions". In current loss estimation models socio-economic models are brought in at the third entry point as linear "damage-consequence functions" for the estimation of direct social and economic losses. Bringing in socio-economic models at the first entry point shown in Figure 1 as empirical models requires the systematic collection of post-event social and economic post-earthquake data which is currently not feasible.

Contributing to the challenge of integrating social vulnerability with physical vulnerability models is the fact that social vulnerability is a fundamentally relative phenomenon and not something that can be directly observed and measured. Thus, one of the main objectives in WP4 is adoption of an indicator system and common nomenclature which posits socio-economic vulnerability in relational terms with respect to both shelter and healthcare systems. Consequently, transparent and validated indicator systems, which characterize the human, institutional and functional vulnerability (and resilience) of the system have to be defined. A set of preliminary indicators have been selected and harmonized with available data in Europe according to the EUROSTAT Urban Audit variables available at the sub-city district level. Here guidelines for the selection of indicators for each socio-economic sector is currently being developed based on benchmarking of indicators with respect to observations from the L'Aquila event, and validation of indicators with experts for each socio-economic sector.

In addition to the activities in WP4, a comprehensive overview of existing methodologies and approaches for deriving urban information from satellite images has been developed for an activity in another work package. This report forms the basis for the selection of suitable techniques for extracting inventory information of the study sites selected within SYNER-G.

Outlook

The aim of the socio-economic loss and vulnerability work package in SYNER-G is to develop a metric by which social and economic vulnerability (and resilience) is accounted for in terms of recovering from the immediate impacts of an earthquake. For example, evacuation demand or temporary shelter planning may be identified not only on the basis of potential damage to buildings, but also on the basis of the differential socio-economic vulnerability of the affected population and their respective needs. The novelty of the proposed approach is the conception of an integrated (socio-physical) vulnerability model which links theoretical frameworks of

vulnerability used by social scientists to quantitative frameworks of vulnerability required by engineers in loss estimation models.

A coordination workshop was held with SYNER-G partners in Karlsruhe on the 17-18th of June 2010 to discuss and find consensus on the central terms of WP4 including what aspects of socio-economic vulnerability and impacts will be taken into account. Each of the participants in WP4 respectively presented areas of potential contribution which were then discussed by the group. The interface between socio-economic vulnerability and the general methodology in SYNER-G was discussed again in Vienna on the 17 and 18th of September 2010. Partners from CEDIM, Norwegian Geotechnical Institute (NGI) and Middle Eastern Technical University (METU) met in Ankara, Turkey, on the 7 and 8th of October to further exchange ideas on the development of a common framework methodology. An additional meeting on the 8 and 9th of November in Rome, Italy, where issues related to the methodology, software and benchmarking were discussed with partners from Bureau de Recherches Geologiques et Minieres (BRGM), University of Rome (UROMA) and the Center for Analysis and Monitoring of Environmental Risk (AMRA). The first deliverable of the project due in April 2011 is the definition of a system of representative socio-economic indicators with respect to emergency health care and temporary shelter.

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Disaster Management

The Web service „Wettergefahren - Frühwarnung“

Aim and objective of „Wettergefahren - Frühwarnung“

The online information service „ Weather hazards - early warnung“ (Wettergefahren-Frühwarnung) provides information about current or future extreme weather events on a daily basis. The websites are constantly available and updated several times per day if required. Routine operation started on 1st of February, 2004, and was continuously maintained. Currently, daily page impressions amount to 1500-2000 approximately.

Extreme weather events include:

- (Intense) Low-pressure systems that present a significant hazard for the inland or coastline.
- Weather conditions in summer favorable to widespread and heavy thunderstorms accompanied by heavy rain, local floods, hail or heavy squalls.
- Extreme precipitation events with flooding (e.g., caused by intensive continuous rain, snow melting)
- Extreme warm periods and cold spells, as well as weather events leading to large temperature deviations from the longterm mean or resulting in hazards for agriculture (e.g. late frosts, early onsets of winter, droughts)
- Tropical cyclones (hurricanes, typhoons) and tropical storms or depressions, in case they cross inhabited islands or hit the shore in a populated area.
- Other events, such as volcanic eruptions, forest fires.

Although the main focus is on events in Middle Europe, even floods due to heavy monsoon rains in Southeast Asia, for instance, or abnormally heavy onsets of winter in New Zealand are taken into account.

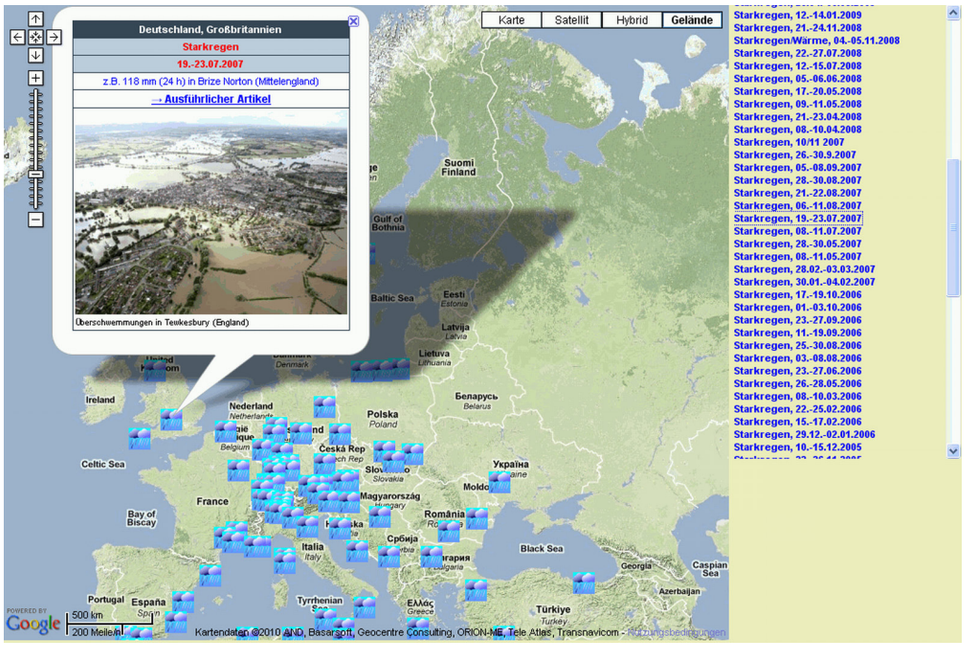

Fig. 1: Screenshot from the archive of: www.wettergefahren-fruehwarnung.de
Interactive result selection of more than 500 events since 2004.

From Early Warning to Analysis

Decisions are made based on model outputs of various global (mainly of the American GFS model) and partly also regional models. These calculations are available online and used operationally by the national weather service and other institutions.

If there is an extreme weather event, suggested by the model forecast and verified by an authorized person, a pre-warning or a warning is formulated one to four days prior to the probable date of event. It contains information which areas can be affected and what they have to prepare for. These warnings are updated daily, in special cases even several times per day. Approximately one to three days after the event a detailed analysis is available. In an extensive article, readers get a review of the event, receive comprehensive information about its progress and learn about measured wind velocities, temperatures and rain fall amounts. Research for the edited articles spreads over all websites with relevant content, data and information.

All warnings, notes and extensive analyses can be referred to in a constantly growing archive which encompasses around five hundred extreme weather events by now.

Routine Operation and the Visualization Tool

In addition to a daily observation and assessment of weather events worldwide, routine operation includes the generation of particular maps and images. For this purpose, more extensive and complex programs have been developed in recent years, which by now produce, four times a day, hundreds of special maps for the whole world. Applying these maps to the familiar and popular maps of google allows a completely new and convenient navigation. Thus, putatively vulnerable areas or cities can be identified directly.

This form of visualization and this service make high demands on computer architecture and programming and, not least, a constantly growing effort in terms of organization and personnel is necessary.

Additional Information

Beyond pre-warnings, warnings, and analysis, the websites provide all information necessary for reviewing extreme weather events. This includes, for example, wind and storm scales, record temperature and rain data on a national and international level as well as detailed climatologic information and maps. This informa-

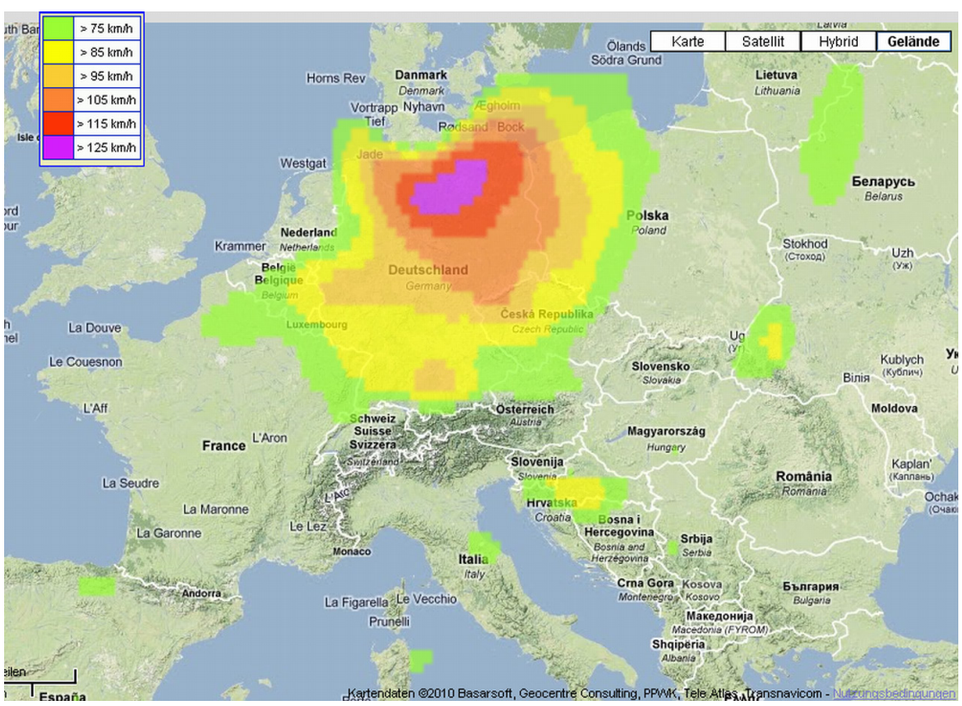

Fig. 2: Intense low-pressure system „Xynthia“.

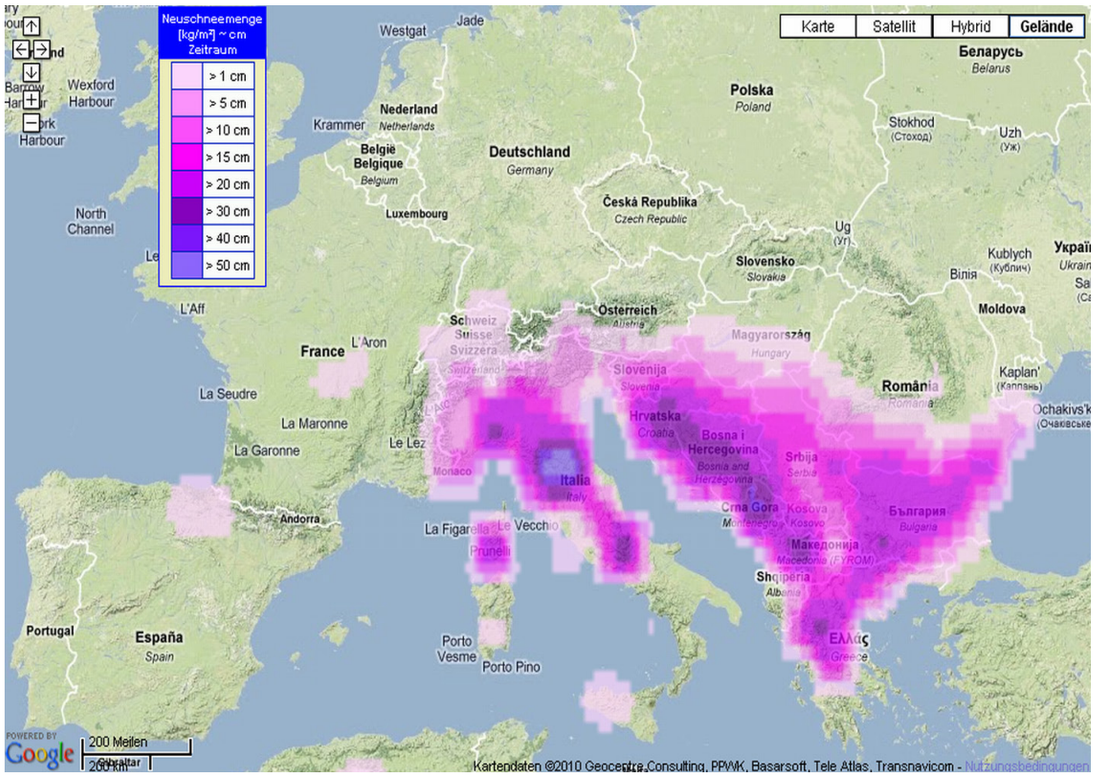

Fig. 3: Heavy snowfall at the Mediterranean.

tion also is verified, supplemented and updated. Special articles concerning, for example, the “summer of the century“ 2003 or the volcanic eruption of the Eyjafjallajökull in March/April 2010 enrich the offer.

Outlook

The warning service shall be continued, improved and new early warning and visualizing methods shall be developed.

A tabular overview for Germany, Europe and the other continents, where every factor relevant to warning and all warning levels for more than 2000 cities can be directly read, has been implemented recently but still has to be optimized.

Currently, new worldwide special maps, that mark vulnerable cities and colour them according to their warning level, are developed.

Note

The “Wettergefahren-Frühwarnung” project is operated independently from the official warning sites of the national weather service and without guarantee. Rules of conduct and recommended actions for individuals, businesses or authorities are not subject of the warnings.

Web addresses:

www.wettergefahren-fruehwarnung.de

www.vorhersagezentrale.de

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Geoinformation Management

Web-based information system CEDIM: RiskExplorer

Introduction

Within the CEDIM project Riskmap Germany, maps of hazard, vulnerability and risk were developed for earthquakes, winter storms, floods and some man-made hazards. To make these results available to the scientific community and interested decision makers, the web-based information system RiskExplorer Germany was developed based on the software ArcIMS. The technical basis of this viewer was found to be dated, both in terms of speed and usability. Therefore, RiskExplorer was to be re-implemented using up-to-date web mapping components.

Based on the work of the Riskmap Germany, the CEDIM working group „synopsis of natural hazards“ performed a multi-risk study for the federal state of Saxony, in which risk caused by flood, earthquake and winter storm were compared for all municipalities in Saxony based on a consistent methodology. These data, too, should be made accessible to interested scientists and decision makers via the Internet. Maps are appropriate media for spatial risk comparison; however, a single static map is not adequate to present the results of multi-risk study comprising several return periods. Therefore, the results of the working group „synopsis of natural hazards“ are made available in an interactive web-based information system. This system RiskExplorer - Risk comparison for Saxony is to supplement and extend the CEDIM RiskExplorer platform.

Aims / Objectives

The RiskExplorer Germany was implemented using up-to-date technology to improve speed and usability. The data is stored in a PostGIS spatial database and is made available using the WebMapService component of the server software Geoserver. The presentation in the

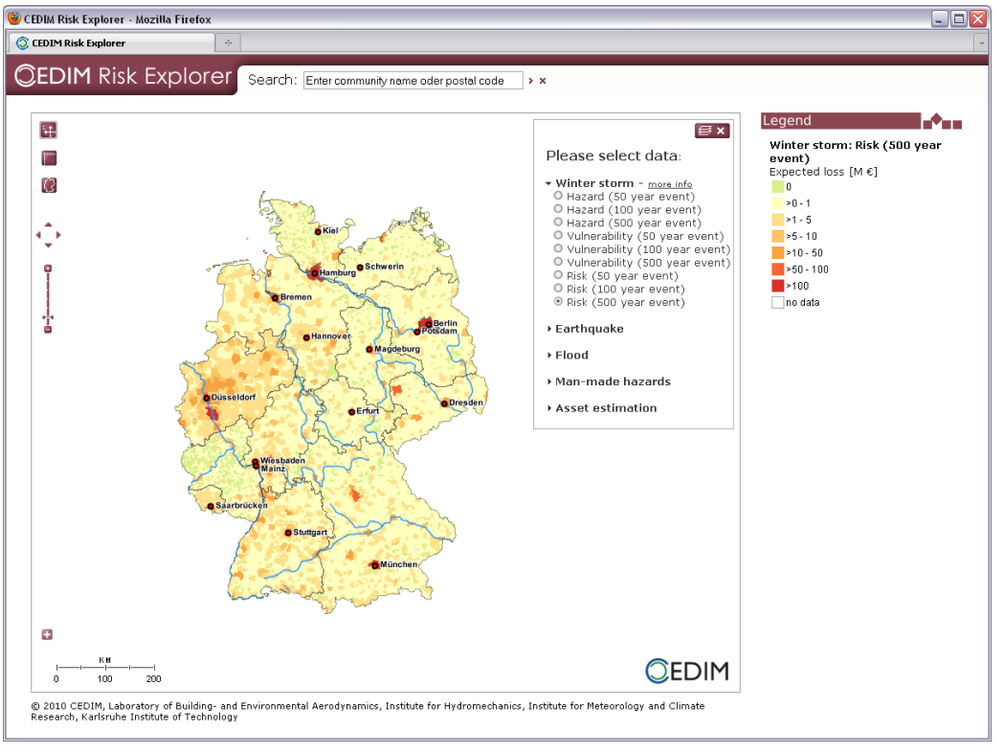

Fig. 1: The new RiskExplorer Germany.

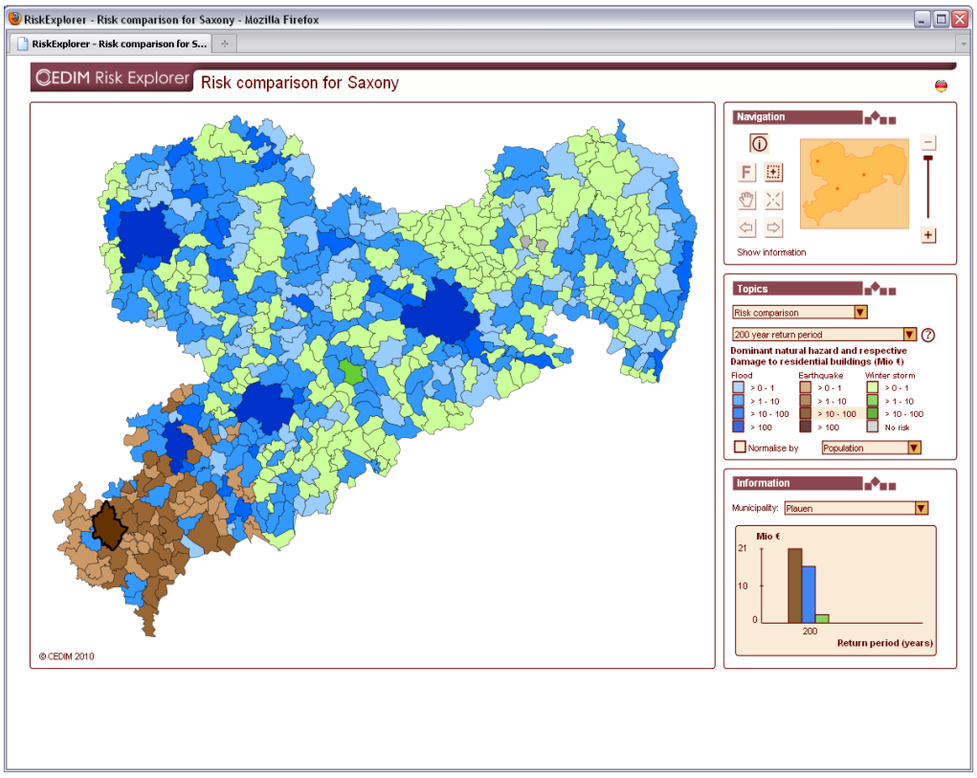

Fig. 2: RiskExplorer – Risk comparison for Saxony.

web is implemented using Open Layers client. Using these new software packages, the speed of RiskExplorer Germany could be significantly improved. In addition, the design and user navigation were simplified considerably.

To present the results of the risk comparison for Saxony and to make them available to scientist and decision makers, an interactive web-based information system is developed based on Scalable Vector Graphics (SVG). The user can explore thematic maps of the spatial distribution of the individual risks as well as a risk comparison for different return periods. In addition to the maps, a graph of the risk for all return periods for a selected municipality is displayed. The risk values (expected loss from residential buildings) can also be normalized by population, area or value of residential buildings. This estimation of relative risk can be useful for the comparison of different communities.

Project status

The new RiskExplorer Germany and RiskExplorer – Risk comparison for Saxony are implemented and available via the CEDIM website.

Publications

Dransch, D., Rotzoll, H. and Poser, K. (2010): The contribution of maps to the challenges of risk communication to the public. International Journal of Digital Earth, 3(3) 292 – 311.

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Humans as Sensors

Integration and assessment of information from the affected population for flood disaster management

Introduction

For disaster management and rapid loss estimation, it is important to quickly gain an overview of disaster impacts and resulting losses. For this overview, information from different sources such as different sensors, satellite images or observation of rescue teams need to be combined and analyzed in order to be useful for decision making in disaster management and for post-disaster event analysis. Until recently, observations of eye witnesses and affected people were not systematically included in disaster management and rapid loss estimation. However, such information can be an important contribution, in particular for disasters with a great spatial extent or when disaster parameters cannot be measured.

Aims / Objectives

The overall aim of this research is to make observations of the affected population usable for disaster management. Using rapid flood loss estimation as an example, methods for quality assessment of such observation are developed in this project. The main questions to be addressed are:

- Which required information can be supplied by the affected population with sufficient quality? How can this information be collected?
- How can the quality of this information be assessed and controlled?

The research comprises two parts (see Fig. 1). In the first part, the quality of observations from the public for flood events will be assessed using existing data from telephone interviews. The results of this study are used in the second part of the research to develop an automated procedure for assessment of observations from the public to be used in a prototypical implementation of web-based data collection for flood events.

The quality assessment of existing data is based on telephone interviews with people affected by the flood in the Elbe and Danube river catchments in 2002 as well as the flood

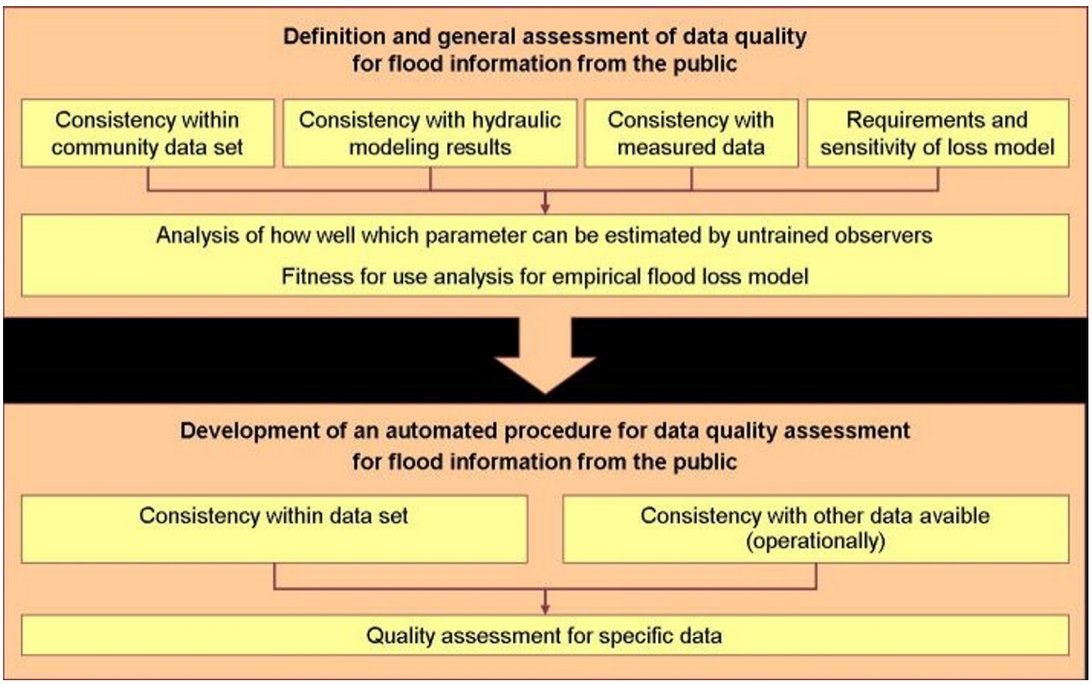

Fig. 1: Methodology of the project.

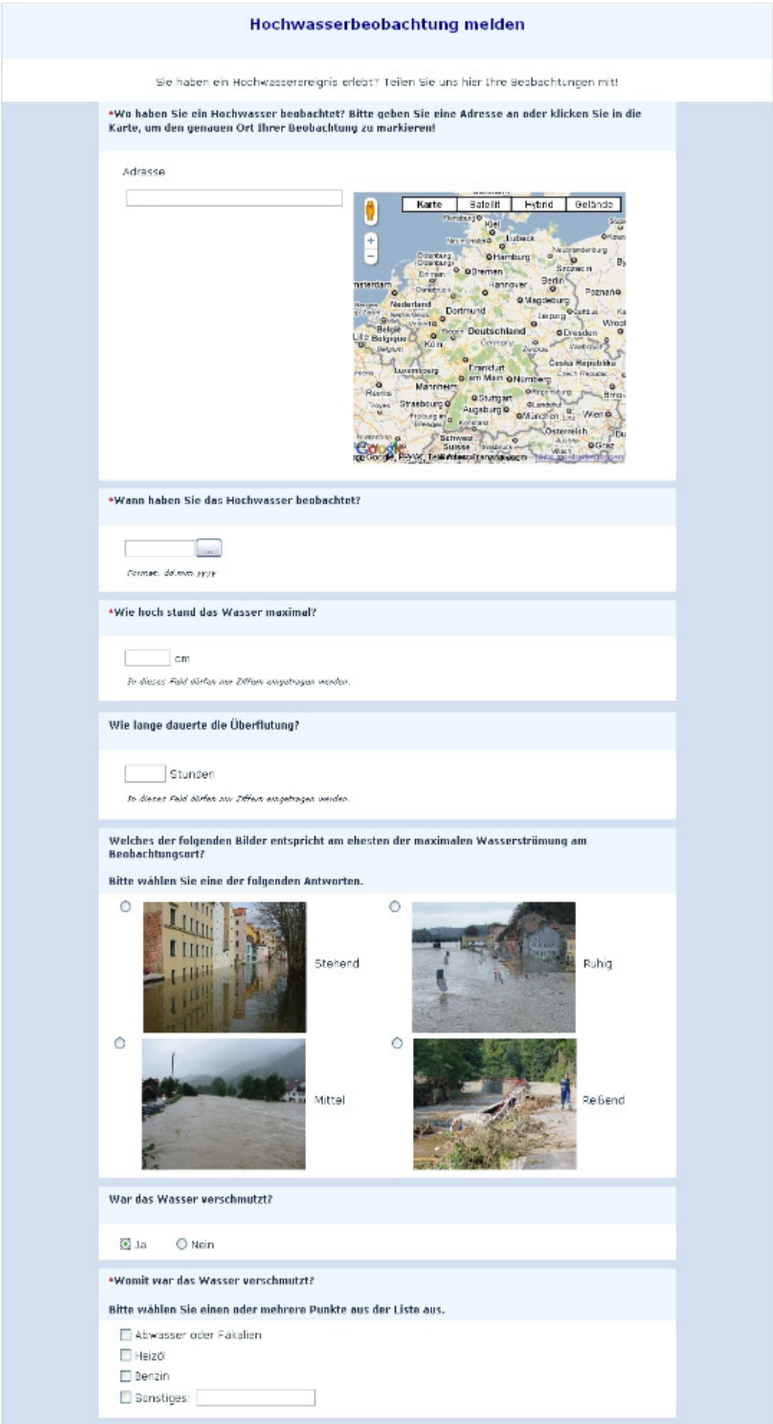

Fig. 2: The web interface for the collection of observations from the affected population.

in the Elbe river catchment in 2006. In more than 2000 interviews, the affected people provided information on flood parameters, private prevention measures and flood damages. In this project, data on inundation depth and flow velocity are used. Inundation depth is of particular interest, as it is the main flood parameter used in loss estimation. The data from the telephone interviews is analyzed for consistency within the data set, consistency with measured inundation depths and with data from hydraulic modeling as well as with satellite images. Next, a fitness-for-use analysis is performed to determine whether the observations of the affected population are adequate for use in empirical flood loss modelling. Based on these results,

an automated procedure is developed that allows collecting, assessing and using of information provided by the affected population for rapid flood damage estimation in a web-based system that is prototypically implemented.

Project status

The data from the telephone interviews has been analyzed for consistency within the data set. On the one hand, for several indicators for flow velocity it was checked, whether these indicators were consistent within individual questionnaires. Moreover, the spatial consistency of the flood impact parameters inundation depth, flood duration, flow velocity, and contamination was analysed. For a number of municipalities in Saxony, for which reference data were available, the consistency of estimated inundation depths and flow velocities with modeled data was assessed. In addition, estimated inundation depths were compared with measured values and the resulting flood extend was compared with satellite-derived data.

Using the municipality of Eilenburg on the Mulde River as an example, which was heavily flooded in the 2002 flood, the fitness-for-use of the observation of the affected population for empirical flood loss modelling was analysed. Loss to residential buildings was modeled using FLEMOps for both the interpolated data from the interviews as well as modeled inundation data. These loss estimates were compared with damage data from the Saxonian Relief Bank.

For the web-based data acquisition, a web interface was developed (see Fig. 2), which allows the affected population to report observed flooding. First, the location of flooding (either given as an address or via a clickable map) and the time of flooding are prompted, then the flood impact parameters maximum inundation depth, flood duration, flow velocity (as a verbal description with the aid of example images) as well as contamination. In addition, the user can post additional comments and descriptions and upload images. The answers to this survey are stored in a database and can be visualized as point data. When sufficient data are available for a municipality, inundation extend and depth shall be interpolated from the observed data and be used for damage estimation using FLEMOps.

Outlook

The work shall be finished and submitted by the end of the year.

Publications

Poser, K., Dransch, D. (2010): Volunteered Geographic Information for Disaster Management with Application to Rapid Flood Damage Estimation. Geomatica, 64(1), 89-98.

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Crisis management for large-area power blackouts

The example of Baden-Württemberg

Introduction

Project duration: January 2008 – September 2009

Project partners:

Federal Office of Civil Protection and Disaster Assistance (BBK)
Ministry of the Interior of Baden-Württemberg
Ministry of Economics of Baden-Württemberg
Energie Baden-Württemberg AG (EnBW AG)

Since almost all social, economic, technical and administrative activities depend on an undisturbed availability of electricity, the power supply system is very critical for the functioning of a modern society. Although the German power grids meet high security standards, the electricity supply can be disrupted by technical failure, human failure, sabotage or natural disasters.

During the last years several power blackouts which caused large-area and long-lasting supply disruptions occurred, e.g. the power blackouts in Switzerland and Italy 2008 and the power disruption in the central and southern part of Europe in 2006. In the north-western part of Germany, in 2005, heavy snowfall in combination with extremely low temperatures caused a power blackout, which last for up to seven days in some regions. Depending on their spatial and temporal dimension power disruptions can cause serious economic and social impacts (see Fig. 1).

Real power blackouts as well as power disruption scenarios, practiced in crisis management exercises, showed that in order to reduce potential impacts of power disruptions, a clearly structured and well planned crisis management strategy is necessary. Within the crisis management process, especially the cooperation between private and public stakeholders plays an important role. Here, communication and

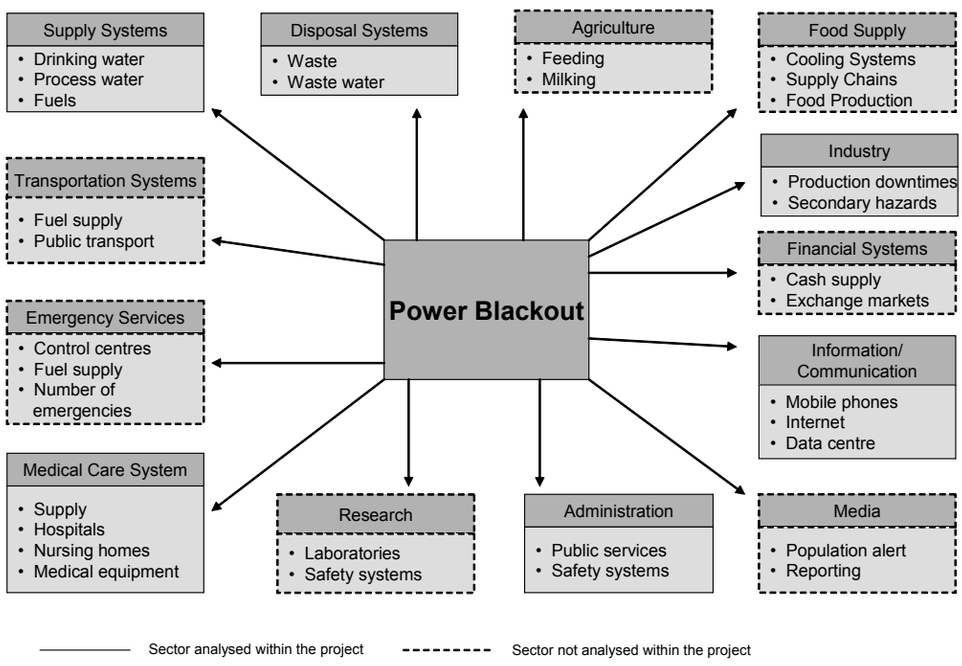

Fig. 1: Impacts of power blackouts within critical infrastructures and social sectors.

the exchange of information is often a challenging task.

Aims / Objectives

Thus, the development of a handbook which can be used for decision support within operative and strategic crisis management in the event of large-area power blackouts has been the central objective of the project. The handbook can be used by power suppliers and public authorities as well as by affected companies and social institutions. The developed handbook consists of two parts. The first part contains background information on the electricity system, on legal regulations and about crisis management structures. Furthermore, a detailed impact analysis is depicted. Within the second part of the handbook checklists are provided in order to support the identification and planning of crisis management measures.

The reported results of the LÜKEX 2004 exercise have been the starting point of the impact analysis in the four selected sectors ("medical care system", "supply and disposal systems", "industry", "information and communication systems"). Furthermore, to gain more detailed results on potential consequences of power blackouts moderated workshops and expert interviews have been held.

Based on the impacts of power blackouts, identified within the conducted workshops and interviews, potential crisis management strategies and measures have been defined and described in checklists. The results pointed out, that for a successful crisis management in the event of a large-scale power disruption, prevention measures as well as emergency measures must be planned. Furthermore, it became evident that in the aftermath of a power blackout specific recovery measures are necessary as well. Therefore, the handbook contains checklists, describing prevention measures, emergency measures and recovery measures. Within the 56 checklists, general measures which can be implemented by all types of users as well as user-specific measures are explained. Figure 2 gives an overview of the topics covered by the checklists of the handbook.

The development of the handbook has already been finished in 2009. Within 2010 the Handbook was released by the Ministry of the Interior of Baden-Württemberg and the Federal Office of Civil Protection and Disaster Assistance (BBK). 5000 Handbooks have been disseminated to the different users in Baden-Württemberg as well as to user groups on a national level.

In order to inform the users in Baden-Württemberg about the handbook content, a "road show" has been realised by the Ministry of the Interior of Baden-Württemberg (14th July 2010). Furthermore, the handbook has been disseminated into other federal states of Germany via the „AK der Innenministerkonferenz der Länder" – the permanently existing, official board of the Ministers of the Interior of all federal states. Additionally, the results gained during the handbook development have been presented on a workshop organised by the „Office of Technology Assessment at the German Bundestag (TAB)" and at a meeting of the „Zukunftsforum Öffentliche Sicherheit" in Berlin.

Currently, the cedim AG implements the handbook within a pilot-project in a medium-sized municipality. Here, the development of blackout-specific emergency plans is supported by the knowledge and experience of CEDIM..

Fig. 2: Crisis management measures described within the checklists of the handbook.

Project Status

The Project has been successfully finished and the results have been disseminated.

Publications

Hiete, M., Merz, M., Trinks, Ch., Grambs, W., Thiede, T. (2010). Krisenhandbuch Stromausfall Baden-Württemberg - Krisenmanagement bei einer großflächigen Unterbrechung der Stromversorgung am Beispiel Baden-Württemberg, Innenministerium Baden-Württemberg (Hrsg.).

Hiete, M., Merz, M., Schultmann, F. (2010): Scenario-based impact assessment of a power blackout on healthcare facilities in Germany, International Journal of Disaster Resilience in the Built Environment, (submitted).

Merz, M., Hiete, M., Rostal, D., Bertsch, V. (2009): Multi Criteria Decision Support for Business Continuity Planning in the Event of Critical Infrastructure Disruptions, International Journal of Critical Infrastructures, 5 (1/2), 156-174.

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Institute for Industrial Production, KIT

Security2people

Security Research Program sponsered by the Federal Government

Project duration

June 2009 – May 2012

Project Partners

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Institut für Technologie und Management im Baubetrieb, KIT, Campus Süd BBK, 53127 Bonn, Germany
CAE Elektronik GmbH, 52220 Stolberg, Germany
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Dialogik, 70176 Stuttgart, Germany

Introduction

The project SECURITY2People (Secure IT-Based Disaster Management System to Protect and Rescue People), that is part of the German Security Research initiative, aims at exploring the needs for and the structure of an integrated disaster management system. This system should be applicable for all types of emergencies and at all levels of disaster management from the local to the Federal Government. In addition, operators of critical infrastructures and organisations dealing with security issues are also envisaged as future users of that system. The following functionalities are major components of the system:

- Role-based information management;
- Decision support at all levels of management;
- Different types of simulation techniques;
- Applicability in training, exercises, planning and operation.

An important feature of such a system is the appropriate information exchange between different stakeholders and public communications. For this purpose, social and psychological aspects of crisis communication have to be explored. Crisis communication is most effective if undertaken in a systematic way. The system shall support the end users at an early stage in order to elicit interest and stakeholder input. Communication must then continue throughout the entire process.

Finally the system has to be designed in such a way that existing specialised management

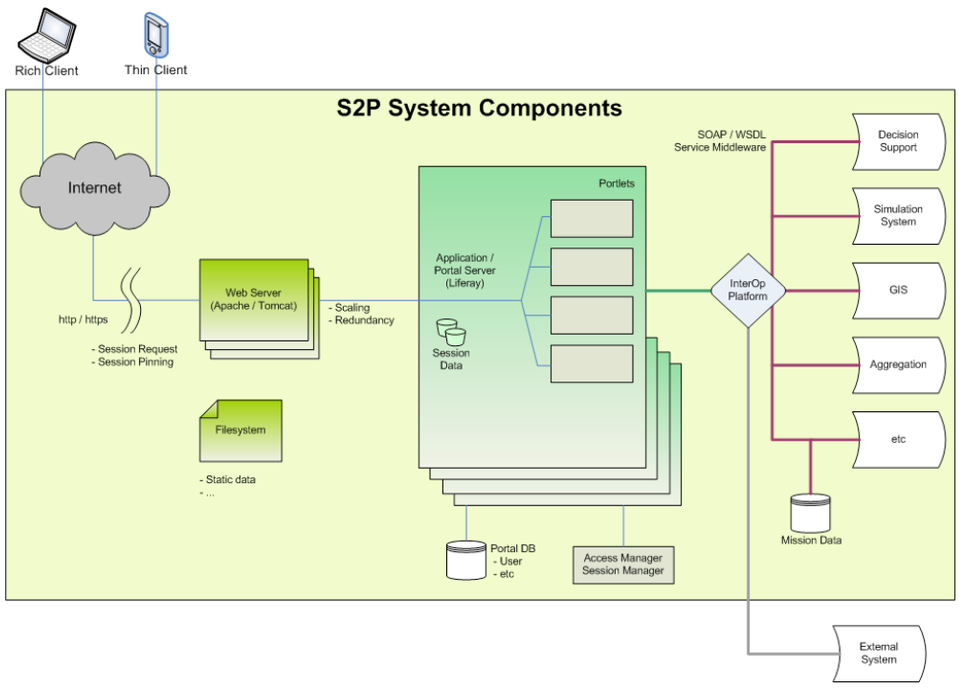

Fig. 1: System design.

tools can be integrated into SECURITY2People.

As such a system can only be designed with the strong support of potential end users, ten executives from police, fire brigade, rescue services, operators of critical infrastructures and public administrations of the German federal state North Rhine-Westphalia (NRW) became associated partners of SECURITY2People. The city of Cologne was selected as test area.

Objectives and achievements

Key objective of the project is to explore the needs of the various end users by analyzing exemplarily the current situation in the emergency management in NRW. To facilitate the interaction with the end users, subject matter expert interviews and two workshops were conducted in 2009 and 2010. The interviews focused on the role and the needs of individual users in the context of an emergency, whereas the workshops aimed to explore the interaction of the various role players in an ongoing crisis situation. To facilitate the interviews, structured questionnaires, tailored to the role of each end user have been prepared. For the first workshop, an exemplary scenario was provided focusing on a large crisis situation in the area of NRW affecting Cologne and its surroundings.

By using Roadmap management processes, this scenario and the end users' different roles were analysed in the workshop. Further important aspects to be considered in the final design are the cognitive requirements for the user interaction and the role-based information needs of the various users.

With the information obtained in the first workshop and interviews, a technological and conceptual design was proposed and several simulation components were presented to the end users in the second workshop. The technological design is based on service oriented architecture principles, considering web services and portlets as central components of the system. PostgreSQL as data base and PostGIS as geographical information extension as well as a MapServer are part of the now emerging design (see Fig. 1).

It was clearly identified, that an important aspect of an integrated disaster management system is the communication between lower (operational/tactical) and higher (strategic) management levels. Decision-making on the strategic level has to consider all aspects of a crisis situation. Strategic decision-making may require only limited information on the applicability of the potential countermeasures; however, the resources associated with and available in the affected area are of high importance.

Therefore, the consortium decided to use an indicator approach to support resource management on the strategic level. As the indicator approach is process-oriented, the support of resource management is also possible on the operational/tactical level. As a consequence, resource management is applicable to validate selected countermeasures on the operational/tactical level. Furthermore, the design of the disaster management system will consider situation awareness components, knowledge data bases and tools facilitating the definition and final selection of countermeasures.

Status

The project started in June 2009 and will last for three years. Work so far focused on the analysis of the current status in emergency management and the functional and technological requirements for such an integrated system. Now in the starting second phase, the results of the analysis will be realised in a concept and a first demonstrator that will provide a basis for further feedback of the associated end users. Within the three years operation, this cycle of analysis, realisation and validation will be repeated three times to assure that whenever a concept is finalized immediate feedback from the end user is considered for the further refinement of the system. The two CEDIM institutes concentrate on the development of simulation and decision support capabilities on both the strategic and the operational/tactical levels.

Outlook

The usage of expert interviews and facilitated workshops allowed the consortium to derive the end users' needs and requirements. Based thereon, a conceptual design of the system and the simulation components were developed. This concept will be evaluated during the next workshop in October 2010. With the proposed iteration process, the system will be refined step by step to become a final demonstrator by the end of the project beginning of 2012.

Acknowledgment

The project SECURITY2People is funded by the Federal Ministry of Education and Research (BMBF) under its Research Programme for Civil Security, which is part of the High-Tech Strategy for Germany.

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EWS Transport

EWS Transport (www.ews-transport.de) is a project financed in the context of the BMBF Programme „Geotechnologies“ (www.geotechnologien.de). Project partners are the Department of Railway Systems (KIT), the Fraunhofer IOSB, Karlsruhe, and the Geophysical Institute (KIT). The project started in 2007 and has been finalized in 2010.

Objectives

The objective of the research project is the development and partial testing of an earthquake early warning system for transport infrastructure, specifically for railway systems. The main component of the project included real-time seismology, risk assessment and risk reduction for infrastructure systems and an information and communication system for achieving these goals.

Project Status

The developed demonstrator can be accessed visiting the following URL:

http://ews-transport.iosb.fraunhofer.de/servlet/is/394/

Outlook

The project gained high visibility by becoming part of the initiative ‚Deutschland, Land der Ideen‘. The developed methodologies and partnerships are currently used to expand work to earthquake prone areas. The first target is Turkey, because the Kandilli Observatory and Earthquake Research Institute (KOERI) acted as partner during the project and open ways to cooperate with the Turkish State Railway. Applications are underway and meetings scheduled. The second target is the Indian State Railway System which currently does not operate bullet trains but, for the first time, allocated financial resources in 2010 to develop a bullet-train system in India. With partnership of IIT Roorkee and CSIO Chandigarh the development of appropriate systems for India and for protection of Himalayan earthquakes are foreseen.

Publication

Hilbring, D., Titzschkau, T., Buchmann, A., Bonn, G., Wenzel, F., Hohnecker, E. (2010): Earthquake early warning for transport lines, Nat. Hazards, DOI 10.1007/s11069-010-9609-3 (online first).

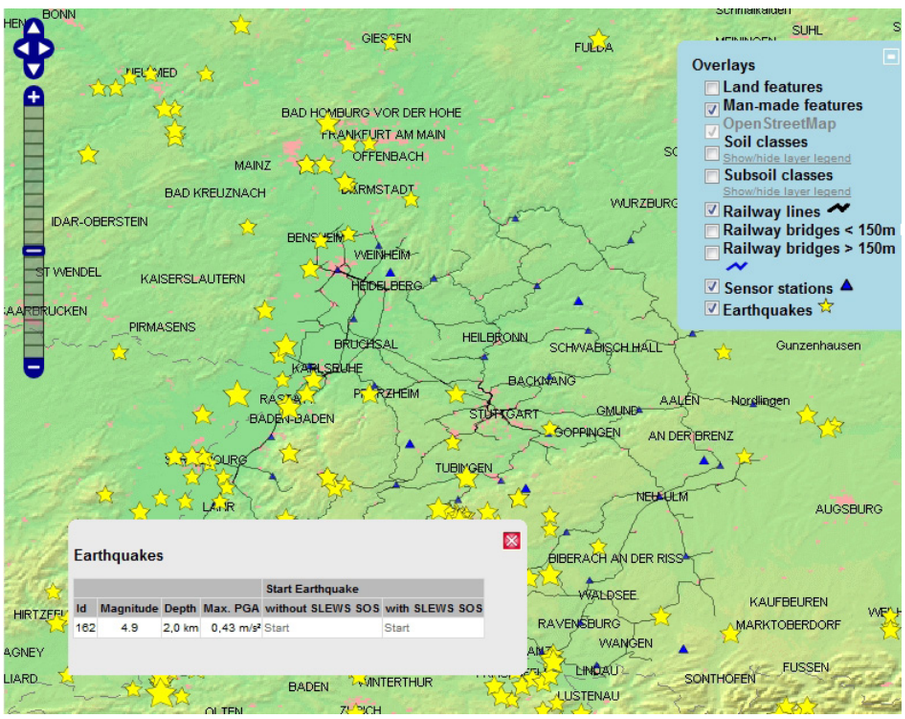

Fig. 1: Demonstrator.

Project EDIM

Earthquake Disaster Information System for the Marmara Region, Turkey

The project EDIM has been funded by the BMBF program ‚Geotechnologien'. It started in 2007 and was finalised in 2010. The main objectives of EDIM were to enhance the Istanbul Earthquake Early Warning System with a number of scientific and technological developments that provide a tool set for earthquake early warning with wide applicability. Innovations focussed on three areas:

1. Analysis and options for improvement of the current system;

2. Development of a new type of self-organizing sensor system and its application to early warning;

3. Development of a geo-information infrastructure and geo-information system due to early warning purposes.

The development in the frame of the Istanbul system that has been set-up and is operated by Kandilli Observatory and Earthquake Research Institute (KOERI) allows testing novel methods and techniques in an operational system environment.

Partners:

Geophysical Institute (KIT) (Professor F. Wenzel, Dr. N. Köhler)
GeoForschungsZentrum Potsdam (Professor J. Zschau, Dr. C. Milkereit, M. Picozzi)
Humboldt University Berlin (Professor J. Fischer, F. Kühnlenz, B. Lichtblau, I. Eveslage)
DELPHI IMM GmbH Potsdam (I. Christ, R. Lessing) lat/lon GmbH, Bonn (C. Kiehle)
Kandilli Observatory and Earthquake Research Institute (KOERI) Bogazici University Istanbul (Professor M. Erdik).

Outlook

Although the project has no continuation within BMBF, funding efforts are being made to implement research results in other contexts, e.g. early warning for the operability of refineries (cooperation with Saudi Aramco).

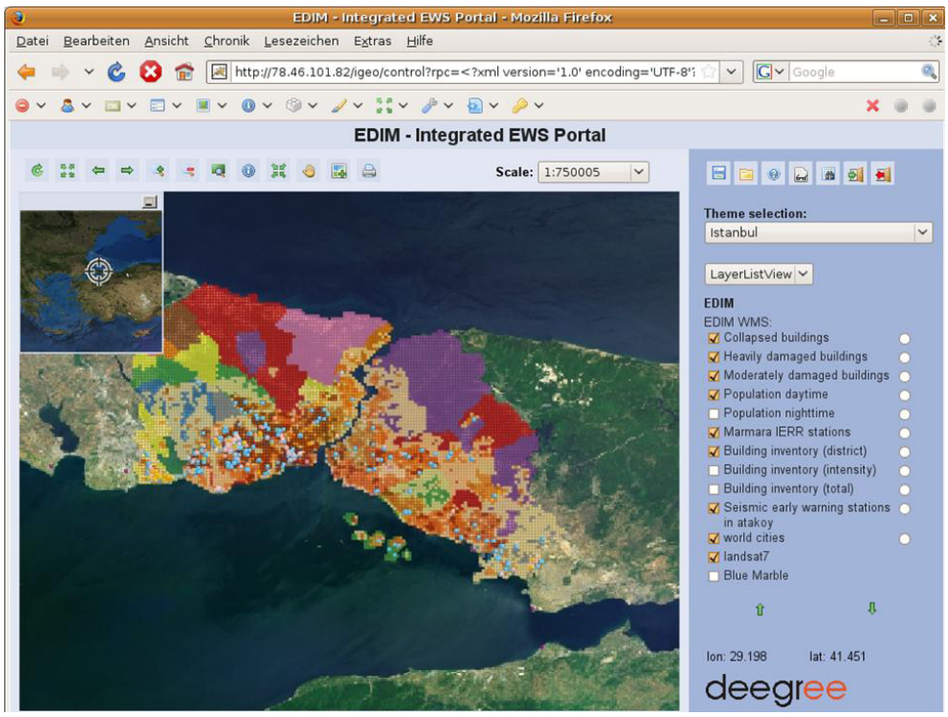

Fig. 1: Integrated Early Warning Geoinformaiton web-portal which allows access to hazard, vulnerability and risk information around Istanbul.

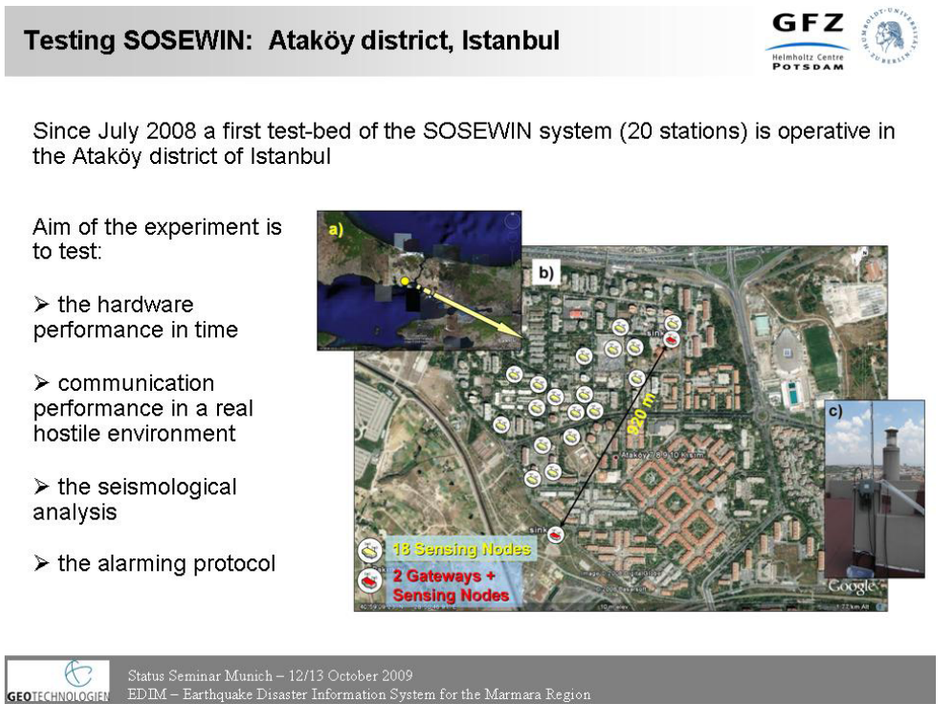

Fig. 2: SOSEWIN Installation Ataköy.

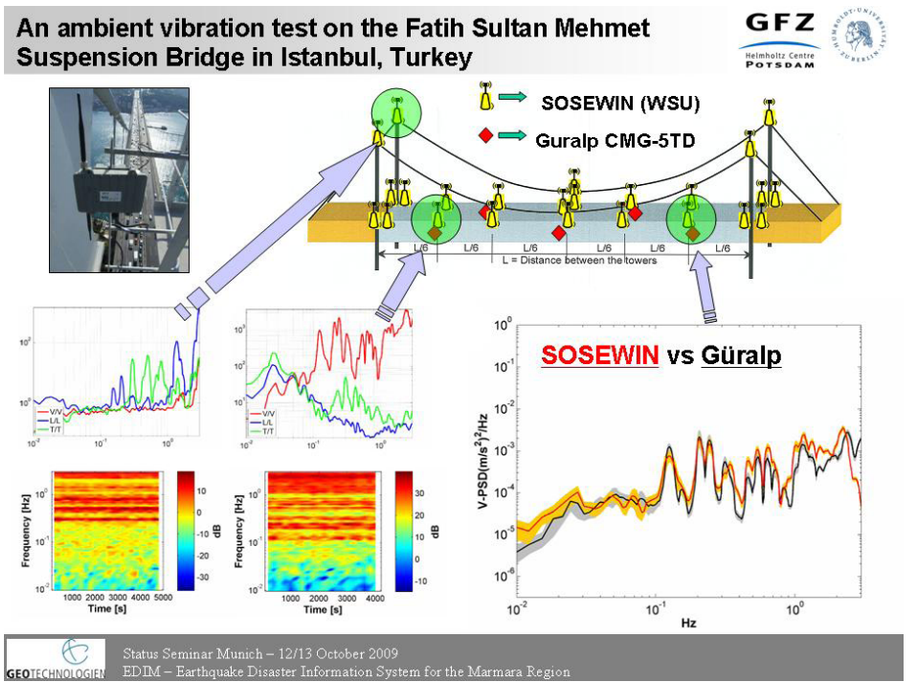

Fig. 3: Installation of sensor system at Fatih Bridge Istanbul.

Core Science Team

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II. Partnerships

cedim AG

cedim AG was founded in 2005 to share CEDIM's knowledge with industry and society for the mutual benefit. Its tasks are to identify results, ideas, developments, and know-how from CEDIM, and from these to generate and distribute products, consulting projects and training contents to the public and private sectors. Through this knowledge transfer cedim AG helps to focus CEDIM's research on the wider needs of society and industry.

Collaborative research with CEDIM

cedim AG is a partner with CEDIM in the research project "Development of attachment systems and elements for the use of earthquake wallpaper on load-bearing walls", sponsored by the Zentrale Innovationsprogramm Mittelstand (ZIM) of the Federal Ministry of Economics and Technology.

Business development with CEDIM

In the past year cedim AG intensified contact with CEDIM researchers to identify business opportunities. cedim AG organized informational workshops in Karlsruhe and Potsdam, and personal discussions with researchers at their institutes. cedim AG staff also participated in the annual CEDIM workshop and the Willis-Research-Network workshop.

Together with GAF AG in Munich and the Global Risk Forum in Davos, cedim AG submitted a proposal for a World Bank-funded project for risk modeling of earthquakes and floods for the insurance industry in Southeast Europe.

cedim AG is also investigating business opportunities in the tourism industry. In particular, cedim AG proposed together with the Institute for Meteorology and Climate research to integrate CEDIM's extreme weather warning data into a crisis management system for European tour operators.

Furthermore, cedim AG and CEDIM researchers are preparing two project proposals in the field of earthquake early warning systems: the first one concerns the validation of the early warning system developed in the Federal Ministry of Education and Research (BMBF) project EWS Transport with the Department of Railway Systems, the Geophysical Institute at the Karlsruhe Institute of Technology, and the Fraunhofer Institute of Optronics, System Technologies and Image Exploitation; the second proposal is a collaborative effort led by the German Research Center for Geosciences GFZ to develop strategies and tools for real time earthquake risk reduction (REAKT).

Current business areas

Community risk management: As in 2009, cedim AG's main focus in 2010 was community risk management. At the beginning of the year cedim AG successfully completed the pilot project in Malsch to implement a risk management concept and software. This project made substantial improvements to the community's risk awareness and emergency planning, making Malsch a model for community risk management.

A new business opportunity for cedim AG is the application of the "Krisenhandbuch Stromausfall", which was edited by CEDIM and published in 2010. The main tasks are to focus the community's effort on the essentials of the handbook and to systematically support its application. In addition, cedim AG participated in a call for proposals for a flood risk management project in cooperation with the consulting office Ernst & Co. in Freiburg.

Business Rrisk management: Building on the experience from community risk management, cedim AG is developing opportunities for risk management projects with small and medium enterprises (SME). In July 2010, cedim AG participated in a workshop organized by Data Sec, a provider of IT security consulting services, and informed more than 50 regional firms about major business risks caused by natural and technical hazards. In cooperation with the IHK Karlsruhe, cedim AG is planning a second workshop for SMEs in February 2011 to foster sales in this area.

cedim AG

Cooperation with the Insurance Industry

Willis Research Network

The cooperation with Willis Research Network WRN has continued and CEDIM's interaction with the Insurance Industry on national and international level has been expanded. WRN (www.willisresearchnetwork.com) is a partnership between Willis – the largest global insurance broker – and academia. Founded in 2006, WRN has entered long-term partnerships with 30 world's leading research institutions from the US, Great Britain, Japan and Italy. CEDIM is the first German partner in the network. Being a member of WRN, CEDIM will receive funding for a full research position within the hail-risk project HARIS-CC.

WRN and CEDIM launched WRN's expansion into Germany with a seminar on "Natural hazards and climate change - Integrating scientific results into risk assessment and reinsurance management" at the German Research Centre for Geoscience (GFZ). In the seminar, CEDIM activities relevant for insurance issues were presented to 80 participants from academia and (re-)insurance companies from Germany, Austria and Switzerland.

As further strategic activity to increase CEDIM's interaction with insurance industry, a workshop with an insurance expert is planned for late winter 2011. One aim of this workshop is lecturing basic principles of the insurance sector. Furthermore, the workshop will be used to identify research problems relevant to disaster insurance and ways how CEDIM could help solving these problems.

Other cooperation with Insurance Industry

Moreover, intensive cooperation has been established in the field of hail and earthquake risk. After the initial meeting in 2009 projects were developed in cooperation with the SV Sparkassenversicherung. Important to mention is also the cooperation with the Vereinigte Hagelversicherung.

The approximately 80 participants of the seminar "Natural hazards and climate change - Integrating scientific results into risk assessment and reinsurance management" at the German Research Centre for Geoscience (GFZ).

Stiftung Umwelt und Schadenvorsorge der SV Sparkassenversicherung

For several years now CEDIM collaborates with the Universität Stuttgart in a joint PhD program „Umwelt und Schadenvorsorge“ by the „Stiftung Umwelt und Schadenvorsorge“, the foundation of the SV Sparkassenversicherung. This PhD program was started to address research gaps in prediction of extreme events and prevention of loss from natural hazards. At the moment one PhD candidate in CEDIM is funded by this program. Her research is focused on the changes in hail probability due to climate change.

In March 2011 the Umwelt und Schadenvorsorge will host a symposium on hail and thunderstorms and related risks, which is part of a seminar series “Natural hazards: novel ways of prevention and risk management.“ CEDIM is involved in preparing and organizing this event.

Fraunhofer IOSB

Within the project EWS Transport cooperation with the Fraunhofer IOSB (www.iosb.fraunhofer.de/, formerly Fraunhofer IITB) has been established. This year 2010 has been utilized to develop the cooperation towards a joint research initiative. We started with a meeting on January 18, 2010, with representatives of IOSB (Professor J. Beyerer, Dr. G. Bonn, Dr. Th. Usländer) and colleagues from CEDIM (Professor D. Dransch, Professor St. Hinz, Professor K. Mitusch, Professor F. Schultmann, Professor F. Wenzel, Dr. W. Tromm, Dr. U. Rickers, W. Raskob).

As joint agenda we identified information systems for critical infrastructure which can serve as decision support systems on various levels (cross level applicability) ranging from operational via tactical to the strategic level. Based on developments in Fraunhofer IOSB and thoughts developed in the CEDIM project ‚SIMKRIT‘ an initial concept for future work under the notion of KRITIS is under development.

Helmholtz-Task Force major disasters

A new initiative emerged in the aftermath of the eruptions of the Eyjafjallajökull volcano in Iceland in April 2010: the development of a Helmholtz Task Force for major disasters which tries to synthesize and visualize the capacities of various Helmholtz institutes with activities in disaster risk mitigation. The aim is to provide relevant scientific information on all aspects of onset and evolution of a disaster in due time.

GFZ, KIT and DLR are the three focal institutions that develop and establish the Task Force. It is intended to expand this to the entire set of EOS Helmholtz institutes. Concepts have been developed under the direction of CEDIM and work has started in December 2010.

SFB/TRR Natural Extreme Events

Concept for a Collaborative Research Center / Transregio

In a first attempt to launch a strategic research program funded by DFG within the partnership of CEDIM institutes and University Potsdam failed in November 2009 due to insufficient coherence between science, engineering and social science projects. The approach to extreme events has been reconceptionalised in the following months and focussed on the research question: How and to what extent can uncertainties for future extreme natural events be reduced and quantified? Given high epistemic uncertainties, e.g. lack of knowledge, how and to what extent are mitigation measures possible and justifiable from an ethical, legal, economic, organisational and political perspective in society?

We developed a new paradime for research work in the field of extreme events: The large uncertainties in the occurrence and the impact of future extreme events lead to a large range of scenarios that cannot simply be associated with a probability distribution. Decision-making for individuals, groups, organisations and in the social sphere like politics, economics, law, etc. does not conform to a scientific multi-objective optimisation approach but is driven by different rational. The question of mitigation of extreme events will be approached by exposing – „stress testing“ – the societal system to impact scenarios. Developing this „stress test“ methodology requires (a) research in forecasting natural extreme events and their physical and socio-economic impact; (b) research and the development on the societal metric to cope with extreme events and uncertainties; (c) merging both research streams and scenario-based „stress test“.

We expanded the partnership to institutions at ETH Zürich as a third pillar in the SFB/TRR. The submission of the draft research paper to DFG is currently under preparation.

MATRIX

The FP 7 project “MATRIX New Multi-Hazard and Multi-Risk Assessment Methods for Europe” was launched in October 2010. An international consortium of twelve research and disaster management institutions and companies will develop methods and tools to tackle multiple natural hazards in a common framework. This includes individual risks from different natural hazard origin, cascade events such as earthquake- and meteorology-triggered landslides and time-dependent vulnerability in the case of conjoint or successive hazards. CEDIM is leading work package 8 – dissemination / end users. In cooperation with GFZ, AMRA and DKKV, CEDIM will develop innovative pathways and new structures for the dissemination of scientific knowledge in the field of disaster management. The dissemination activities will on the one hand target the scientific and technological communities, on the other hand those disaster management communities where decision about mitigation / adaptation measures are likely to be made. In addition of being in charge of the MATRIX dissemination activities, CEDIM contributes to work package 6 – Decision support for mitigation and adaptation in a multi-hazard environment. Researcher at CEDIM will provide a comprehensive review of established management practices and decision-analytic support for multiple hazards.

Disaster Risk Management Program

Online Risk Analysis Course for the World Bank Institute

Introduction

In June 2009, CEDIM obtained funds from the World Bank Institute's Disaster Risk Management Program to develop a comprehensive 5-week modular learning program in risk analysis with a focus on earthquakes and floods. The e-learning program and facilitator's manual in Risk Analysis was completed in May 2010. The learning material was tested at a training of trainers (ToT), and peer review workshop which took place with 43 participants (25 Indian and 18 international) in Delhi, India.

Aims / Objectives

Among objectives of the Disaster Risk Management Program (DRMP) of the World Bank Institute (WBI) is to develop cutting-edge courses in Disaster Risk Management for public officials, decision makers and others involved in disaster risk reduction. The newest course of the program to serve as part of WBI's Distance Learning program is the "Risk Analysis" course. The objective of the Risk Analysis course is to develop a broader understanding among practitioners and policy makers of risk assessment procedures and methods and enhance use and effectiveness in disaster risk management decision making. The course includes presentations (in Microsoft PowerPoint format with corresponding written and audio transcript), case studies, readings, knowledge checks, exercises, discussion forums, and a comprehensive glossary. An end of course project and final exam is meant as an exercise to pull together the content learned in the 3 modules and assignments and apply this knowledge to carry out a multi-risk analysis for a fictional city.

Course Outline

The learning material and supporting activities are implemented in the WBI e-learning. The course is structured around the following three modules:

- Module 1: Fundamental Elements of Risk Analysis. The module introduces basic concepts, and defines hazard, exposure and vulnerability, and risk. It reviews the key components of a risk-based approach and the result of the risk assessment process, including risk mapping, scenario analysis, loss and damage estimation. It also introduces methods of a multi-risk analysis for comparison and ranking of risks.

- Module 2: Earthquake Risk Analysis. The module reviews the components of earthquake risk analysis. It starts with the characteristics of the hazard followed by description of the impact under different soil conditions and site characteristics. Next the module looks into the steps involved in vulnerability and exposure analysis. The earthquake risk analysis methods illustrated for physical infrastructure: buildings and lifelines as well as for the direct and indirect socioeconomic impacts such as business interruption or psycho-social impact. The module concludes with an overview of tools available for earthquake loss estimation and scenario analysis.

- Module 3: Flood Risk Analysis. The module looks at flood hazard, flood risk and flood simulation analysis. It explains the basic hydrologic parameters and flood types followed by the hydrologic cycle and the development of flood plain. The module presents flood risk assessment methods - frequency analysis, hydrologic modeling (1-D) and hydraulic modeling (2-D) – together with the data requirement of these methods. The module concludes with tools for flood simulation analysis. It illustrates how these tools can be used to increase coping capacity through better flood risk communication, preparedness and evacuation.

Outlook

The aim of this course is to provide an overview of the general concepts, essential elements and basic tools and approaches of risk analysis in a language that is accessible also to a "non-technical" community. The authors' expectation is that after the successful completion of the course, the participant will have been made familiar with the fundamental concepts and up-to-date methods for earthquake and flood risk analysis, and through the hands-on focus of the course via analytical assignments and an end of course project, be able to carry out a simplified analysis. Needless to say, risk analysis is a

complex technical endeavour and carrying out a detailed risk analysis requires many years of academic and professional training. However, an understanding of the basic processes and steps in risk analysis (as they apply to earthquakes and floods in this case) by all members of the community involved in disaster risk reduction, is a necessary step to better integrating scientific methods in the practice of disaster risk management.

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World Bank Institute Academic Fellows Program

National Institute for Disaster Management (NIDM), Delhi, India

The World Bank Institute (WBI) Disaster Risk Management Learning program with support from Global Facility for Disaster Reduction and Recovery (GFDRR) collaborates with the National Institute for Disaster Management (NIDM), India to strengthen the capacity of Indian institutions and professionals in the area of risk reduction. As part of the collaboration, competitively selected faculty members of NIDM were provided with the opportunity to improve their skills by participating for three months in an academic fellow program in leading universities. Under this program CEDIM hosted Dr. Amir Ali Khan, Assistant Professor at NIDM for a period of 3 months from April 12 to June 30, 2010. Under the supervision of Dr. Bijan Khazai, Dr. Khan was involved in research and training programs at CEDIM during his stay in Karlsruhe. Particularly he has contributed in the review and analysis of case studies related to post-earthquake displacement and temporary shelter situation for the SYNER-G project. As a facilitator of WBI e-learning courses, Dr. Khan also assisted in the finalization of the course module, especially the facilitator's course manual.

Cooperation with the International Institute for Earthquake Engineering and Seismology (IIEES), Tehran, Iran

Through a collaborative project between CEDIM and the Institute for Earthquake Engineering and Seismology (IIEES), in Tehran, Iran, Mr. Hooman Motamed from IIEES visited Karlsruhe from January 1 until June 30, 2010. Under the co-supervision of Prof. Mohsen Ashtiany from IIEES and Dr. Bijan Khazai from KIT, Mr. Motamed is developing a model for optimizing resource allocations in earthquake mitigation scenarios. The model supports decision maker/stakeholders in evaluating the costs and benefits of several mitigation scenarios of earthquake losses in urban settlements. The optimization algorithms for the model are coded in MATLAB and are structured to find the optimal budget allocations for a given earthquake scenario by taking into account both the pre- and post-earthquake expenditures including costs of building upgrading, critical facility enhancement, provision of temporary shelter, debris removal, and hospitalization. The outputs of the proposed model are presented using an application in a district of Tehran, Iran. The results of this analysis will be presented in a journal publication.

III. Publications 2010

Articles in Journals and Books

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Public Relations

Web page

CEDIM's web page www.cedim.de gives comprehensive German and English information on CEDIM as an institution, on research carried out within CEDIM, and links to the web services developed or supported by CEDIM: the web-based information systems RiskExplorer is accessible online in two versions, and there is a permanent link to the Wettergefahren-Frühwarnung (weather hazard early warnings). The homepage announces important news, outdated news are stored in a news archive. Approximately 1800 national and international visitors per month use the webpage.

Media

CEDIM collaborates actively with the media. It brings out press informations on important research results. In 2010, several regional and national media reported on the handbook for crisis management for large-area power blackouts after the BBK has released a press statement.

CEDIM has become a proficient contact for the media and is contacted by journalists making enquiries about ongoing disasters and disaster reduction. Examples in 2010 are contributions of CEDIM-members regarding the impacts of the Eyjafjallajökull eruptions in April and May, the Haiti earthquake in January, and the Pakistan floods in August.

CEDIM Research Reports

CEDIM disseminates research results in various journals, book chapters and presentations in national and international workshops and conferences. In the end of 2009 CEDIM opened a series of research reports as an additional format. The research reports are available for download from CEDIM's webpage. So far 4 reports are published (see section above).

Public events

CEDIM regularly participates in public science events. In July 2010 CEDIM was presented at „KIT im Rathaus" (KIT in the City Hall), a series of events to build a new bridge and intensify exchange between science and research and the city of Karlsruhe.

During the Open House at KIT on September 25, 2010, CEDIM staff members presented elements of the e-learning course on earthquake risk analysis. In a join-in acitivity using computer animations "see the earth shaking" interested visitors were invited to experiment and to find out the different impacts of different earthquake intensities.