

New Decision-Support Framework for Strengthening Disaster Resilience in Cross-Border Areas

Andreas Lotter

University of Wuppertal, Germany
lotter@uni-wuppertal.de

Florian Brauner

University of Wuppertal, Germany
brauner@uni-wuppertal.de

Alexander Gabriel

TH Köln - University of Applied Sciences,
Germany
alexander.gabriel@th-koeln.de

Frank Fiedrich

University of Wuppertal, Germany
fiedrich@uni-wuppertal.de

Stefan Martini

University of Wuppertal, Germany
martini@uni-wuppertal.de

ABSTRACT

The improvement of disaster resilience in cross-border areas causes special challenges. Involved countries use different structures in their civil protection systems and have to work together facing more difficult conditions than in local incidents. Furthermore, in the past involved countries mainly worked individually and focused on the concerned areas in their territories regardless transnational activities. The project INCA will develop a resilience framework to support decision-makers. The framework will focus on information management, the implementation of volunteers and the needs of citizens who are receiving medical care. Therefore, a case study region on the German-French border was defined and a scenario-based approach will be used to investigate resilience opportunities through disaster collaboration. The tested scenario is a transnational long-lasting power-outage in the German-French region.

Keywords

Cross-border events, cross-border resilience, information management, interorganizational cooperation, disaster resilience

INTRODUCTION AND MOTIVATION

Big incidents are often multinational and cross-border events. (Pappert et al. 2015) E.g. the big flooding in central Europe in 2013 involved the countries Germany, Poland, Austria, Switzerland, Slovakia, Czechia and Hungary. Only in Germany, it caused a damage of about 11.6 billion EUR. (Thieken, 2015) These kind of incidents require cross-border close collaboration between the involved countries to grant effective disaster response actions.

To improve cross-border collaboration a few research projects and research groups have been dealing with this topic such as the EU project DISASTER (Data Interoperability Solution At Stakeholders Emergencies Reaction), which developed a methodical basis for connecting IT-based emergency management systems based on end-user requirements. The generated ontology called EMERGEL (EMERGENCY ELEMENTS) includes linguistic, semantic, legal, and structural issues that are important to share information between all involved countries. The project DISASTER focused on highly applicable interface which allows countries to use their own familiar system instead of untrained new ones. The country specific systems are connected and translated via the EMERGEL platform. (Pappert et al., 2015; Cepeda, 2015)

In this paper a new project is introduced called INCA (A Decision Support Framework for Improving Cross-

border Area Resilience to Disasters), which starts in the beginning of the year 2017 and focus on understanding and enhancing cross-border resilience. The focus is set on the resilience of medical dependent citizens and the management of volunteers in a cross-border area. Therefore, the scenario of a cross-border blackout will be defined. Within this scenario, particular areas both on the French and on the German side will be examined. The chair for Public Safety and Emergency Management at the University of Wuppertal will mainly focus on these topics: management of (spontaneous) volunteers, the resilience of medical dependent citizens and the interagency cross-border collaboration of the response agencies. (Rigaud & Schultmann, 2016)

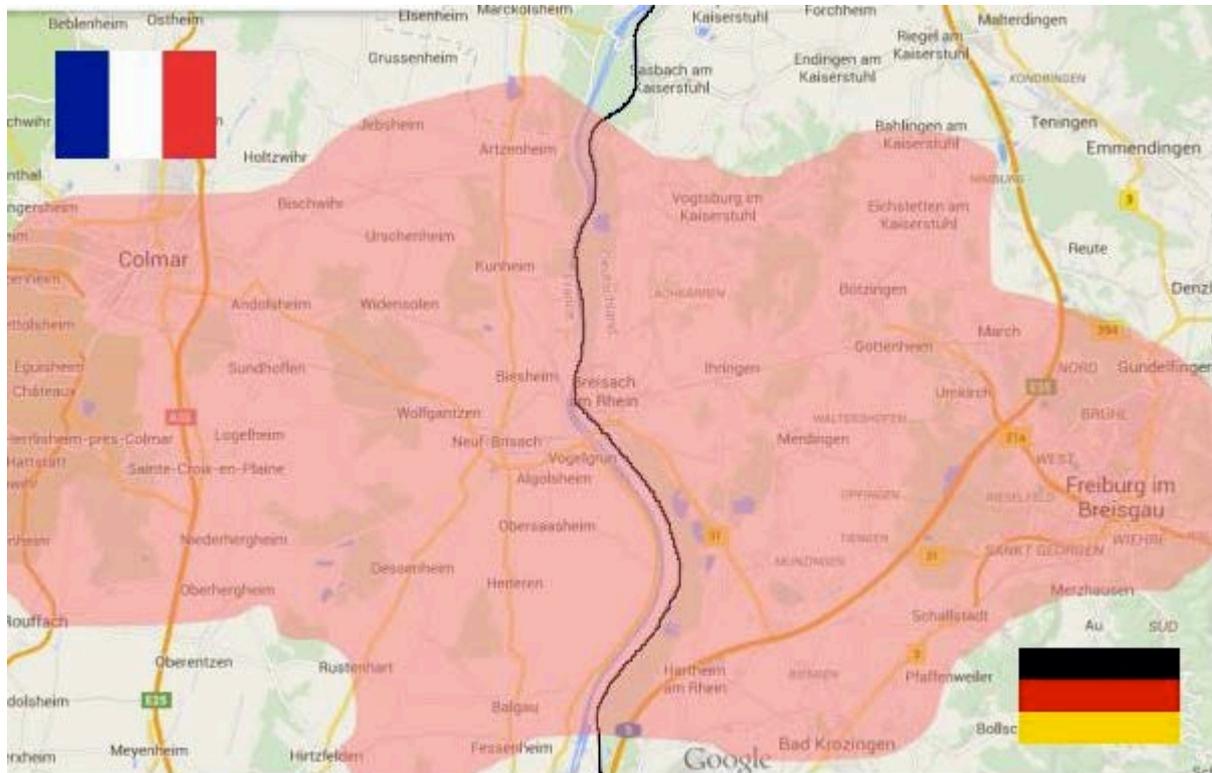


Figure 1: Case study region with possible power-outage (Source: Google Maps modified by authors)

DIFFERENT STRUCTURES IN CIVIL PROTECTION SYSTEMS

One of the main reasons for ineffective cooperation during cross-border events is the differences in structure and culture within the civil protection systems of the involved countries. Not only language barriers but also differences in organizational structures can cause lacks of information for at least one player. Furthermore, the differences in the system can even lead to situations, where parts of the equipment of the involved forces have not the needed admission for other countries and therefore cannot be used as usual. (Ministry of Home and Municipal Affairs North Rhine-Westphalia, 2014, p. 69, 2014) To fix this problem, there are already several approaches: The European Union (EU) has introduced the European Civil Protection Mechanism (ECPM) in 2001. Within this program, the members of the EU (and some other neighbour countries) support the coordination centre with a pool of resources and information. These resources can be used for incidents in other countries within and out of the EU. Since today, this service is well established and has not only been used in Europe, but all over the world for example during the earthquake in Haiti (2010), the triple-disaster in Japan (2011), the floods in Serbia and Bosnia and Herzegovina (2014), the conflict in Ukraine (2014). (European Commission, 2016) Furthermore, the ECPM focuses on the properties of compiling an inventory of assistance and intervention teams, establishing a training programme for members, setting up assessment and coordination teams, establishing a Monitoring and Information Centre (MIC) later called Emergency Response Coordination Centre (ERCC) and a common communication and information system. The established Common Emergency Communication and Information System (CECIS) deals with detection and early warning systems, as well as facilitating access to equipment and transport by providing information on the resources available from Member States and identifying resources available from other sources. (European Commission 2016)

Although, the *European Civil Protection Mechanism* is a system with international partners and members, and forces from different countries, it does not really address cross-border events and does not focus on improving

the close cooperation between two players with different civil protection systems during a common event. Its objective is to support overcharged countries by providing useable resources, which are needed at that moment. Furthermore, the participation *European Civil Protection Mechanism* is voluntary. (European Commission, 2016; Ministry of Home and Municipal Affairs North Rhine-Westphalia, 2014, pp. 67–69)

Other approaches address the problems of cross-border events directly. Good examples for these approaches are common or daily events such as medical emergencies within the region of Germany, Belgium and the Netherlands, which are very well examined. The cooperation is founded on contracts and common, elaborated concepts. These concepts are also addressing the information flow and information exchange between the involved stakeholders of the countries. This leads to better services, e.g. it is easily possible for a German ambulance to deliver the patient to a hospital in the Netherlands. (Ramakers et al., 2007)

German Structure of Civil Protection

The Federal Republic of Germany has a federal political system and is split in 16 states (so called Bundesländer). The responsibility of civil protection is delegated to the federal states. After the Second World War, the allies allowed to found the technical relief organisation as first civil protection institution to help in case of air raids. Later, the *Federal Ministry of Interior* took responsibility for civil protection by allowed delegation. During the development of the *Federal Ministry of the Defence*, the competences of civil protection were strictly divided into the two cases of war time (civil defence) and peace (civil protection). Due to the fact that war affairs are on federal level, each federal state has been responsible for the civil protection in times of peace. The federal states delegate fire protection and emergency medical services to the different counties under the supervision of different district administrations. In 2004 after the two events - the great flooding in Germany and 9/11 - , the Federal Ministry of the Interior established the *Federal Office of Civil Protection and Disaster Assistance* in order to provide a coordination centre for cross-state incidents as well as common educational training of disaster management forces. Today, civil protection is still part of the legal states regulated in 16 different laws but mainly adjusted to same principles. (German Federal Office for Civil Protection and Disaster Assistance, 2010)

French Structure of Civil Protection

Since the French Republic is a unitary republic, the responsibility for national civil protection is allocated at the *French Ministry of Interior* and for regional civil protection at the departmental fire and rescue services. The prime minister of France is responsible for the civil protection in the whole country. Unlike in Germany, in France the systems of civil protection and civil defence are not strictly separated. Rather, both systems share same structures and the fire brigades in Paris and Marseille are even military organizations. Although, there are different ministerial responsibilities for incident management depending on the dimension of the incident (see Figure 2), the *French Ministry of Interior* specifies the structure of the local solutions for the civil protection systems. (Coste et al., 2013; European Commission, 2015)

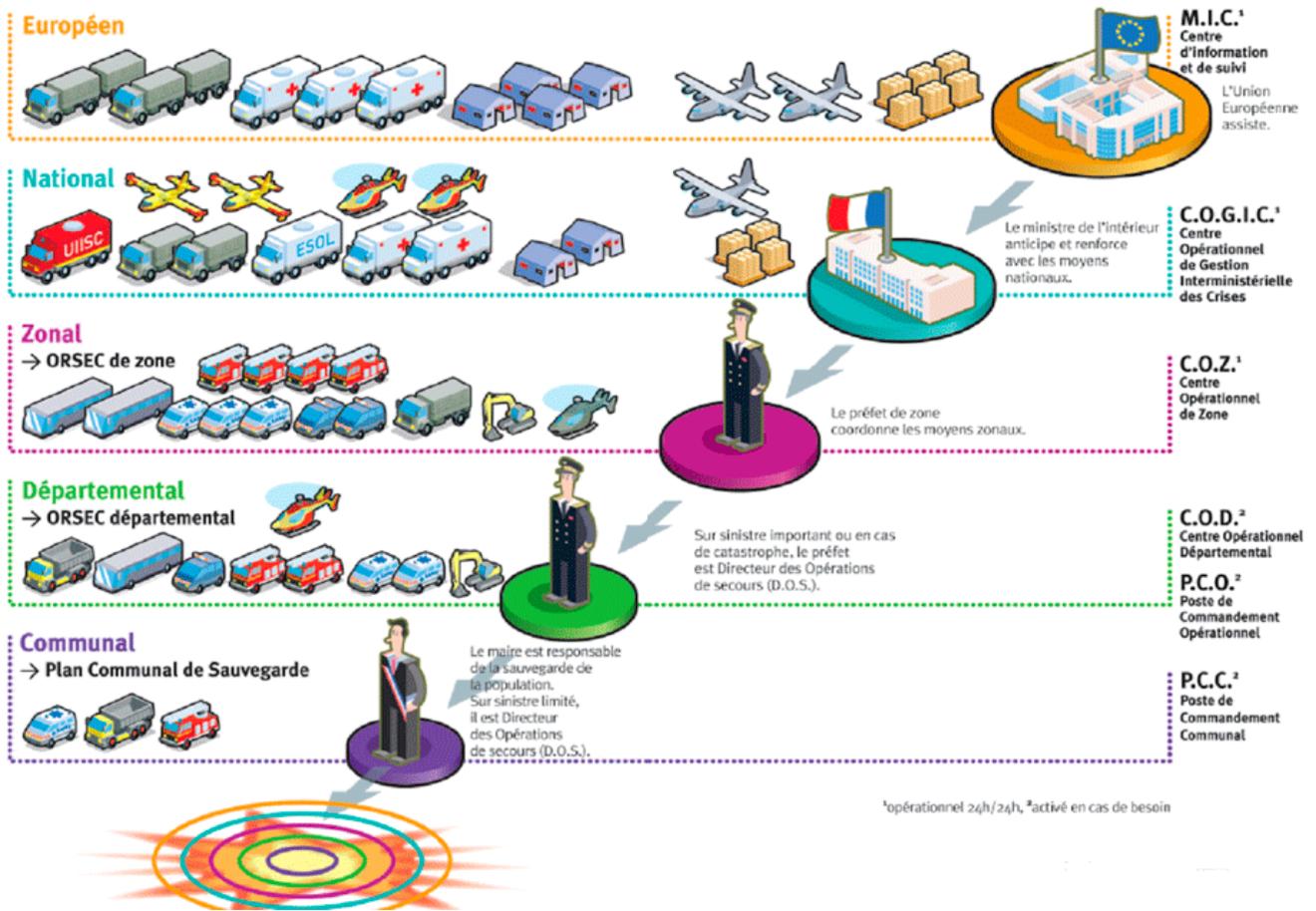


Figure 2: Structure of the French Civil Protection System (Source: Institute for Major Incidents, 2012)

Both nations have a different structure to deal with events concerning civil protection. Table 1 shows the comparison briefly. This has to be considered in the development of a methodology to develop a new decision support framework for transnational disaster management collaboration.

Table 1: Comparison between German and French system

	German system	French system
general organization	federal system (every federal state is responsible for its territory and can make its own laws and plans, the government of the Federal Republic of Germany can never take over control)	centralized system (different responsibilities depending on the dimensions of the scenario, the prime minister of France is responsible for the whole system)
separation in the responsibilities between civil protection and civil defence	yes, federal states are responsible for civil scenarios, the government on the Federal Republic of Germany is responsible for non-civil scenarios	no, there is even a close link between the system for civil protection and civil defence

METHODOLOGY

Within the project INCA, a scenario-based approach will be used. Based on the power-outage scenario and a study case area (Figure 1), the authors will examine different aspects of cross-border events. The main goals are:

- development of recommendations for the implementation of volunteers during cross-border events,
- development of recommendations for improving the international and inter-organizational information management,
- support the development of a decision-support-system,
- analyse the needs of medical dependent people.

Based on the lessons learned in one scenario, in the final phase of the project the results will be transferred to general, scenario-independent recommendations which shall be provided to end-users.

INCA Scenario

In order to keep limit to the research effort to a manageable size, the consortium of project INCA is using a scenario-based approach with focus on a long-lasting power-outage. This scenario is particularly challenging due to its complexity, interdependencies to other critical infrastructures, and great challenges for preparedness by public authorities. For example, the German Federal Office for Civil Protection and Disaster Assistance (BBK) occasionally admitted that long lasting power-outages represent a significant threat as they are by now systematically underestimated. Furthermore, this scenario implies a high level of difficulty as such a threat directly affects emergency services themselves: In contrast to an earthquake, where a given hospital capacity meets an exceptionally high demand, a long-lasting power-outages constrain the needed capacity of health services seriously. Additionally power-outages are actual and transnational problems. Especially fluctuations in the electricity grid (caused by the raise of renewable energy and the use of smart grid technologies) lead to a higher risk. (Leavey, 2012; Lund *et al.*, 2012)

The detailed scenario description will be defined in the initial phase of the project and will include information related to the geographic area, critical infrastructure (CI) interdependencies, health sector details as well as preparation levels of the public. In addition, the ability of resilience capacities of the affected society such as volunteers' involvement and their implementation in civil protection structures will be addressed. As mentioned above, during the final phase of the project a broader set of scenarios (e.g additional natural disasters) will be developed in order to analyse the transferability of the developed decision support framework to other used-cases. (Rigaud & Schultmann, 2016)

Information management in cross-border events

A great challenge of effective disaster response actions during cross-border events is the use of a very well developed information-management-system. Due to the fact that Germany and France are using different civil-protection systems, the information flows between the involved authorities in both countries are not as efficient as on local level.

To improve the international and interorganizational information management, process-modelling and flowchart methodology will be used to identify important connections between the involved forces in both countries. This action has already been successfully used in the past as discussed by Fahland, Woith and Lindemann and within the project VERVE. (Lotter *et al.*, 2015; Fahland & Woith, 2008; Lindemann *et al.*, 2010) The focus within INCA will be set on identifying the connections between the involved forces of Germany and France. To gain the required data, stakeholders and experts will be involved in the process. The focus will be set on interviews with the decision-makers.

Volunteers in cross-border events

Integrating the interaction with volunteers in a dynamic setting of disaster management is also an important step. "Recent examples like the 2013 Elbe flood and spring storms in Germany or the 2013 typhoon Haiyan in the Philippines show that volunteers play a vital role during disaster response." (Rigaud & Schultmann, 2016, p. 6) Since today, these volunteers often work independently from official disaster response authorities/organizations. This might cause problems in coordination and collaboration (Fernandez, 2007) and sometimes additional risks such as putting themselves in jeopardy.

Within the project INCA, the focus will be set on gaining information about the motivational aspects, cultural differences, capabilities, and willingness to integrate in formal response networks of volunteers. A first attempt of evaluating the motivation of volunteers has been executed in an empirical study by Fathi *et al.* in 2015. They conducted a survey questioning volunteers, which were involved in disaster events over the past years. Based on their research INCA will gain more data about the phenomena of the inclusion of spontaneous volunteers

through document analysis, focus groups and structured interviews. (Fathi et al., 2015)

The focus in INCA will not be set on the inclusion of all spontaneous volunteers together and in both countries. Furthermore the project will examine how to implement volunteers in the most effective way, e.g. split the volunteers into small groups, led by professional forces, merge all volunteers and deploy them together or support them within the work, they are already doing.

Citizens receiving medical care

Apart from the improvement of disaster-information-management and the integration of volunteers during cross-border events, the project INCA will also analyse the impact of the power-outage on citizens receiving medical treatment. Especially this scenario has enormous consequences for this group of citizens that cannot be neglected. Not only hospitals, retirement or nursing homes must be considered as well, but also medically treated citizens who are living in their own homes. Today, some organizations provide shared flats for inhabitants that are depending on respirators. These flats are not registered and an increasing challenge. Unlike hospitals or nursing homes, “ordinary” flats do not have an emergency power supply, which provides electricity for the respirators during power-outages. Nevertheless, not only electricity is needed for high-tech medical devices, fresh water supply, heating and food supply have be considered as well. In the future the demographic change will cause a rising number of senior citizens in the population and therefore an assumed increase of citizens dependent on medical treatment as well. (Rothgang et al., 2015; Petermann et al., 2011)

The INCA decision support framework

The project INCA addresses the above challenges by developing a methodical resilience framework. Figure 3 shows the structure of the research framework and its methods briefly.

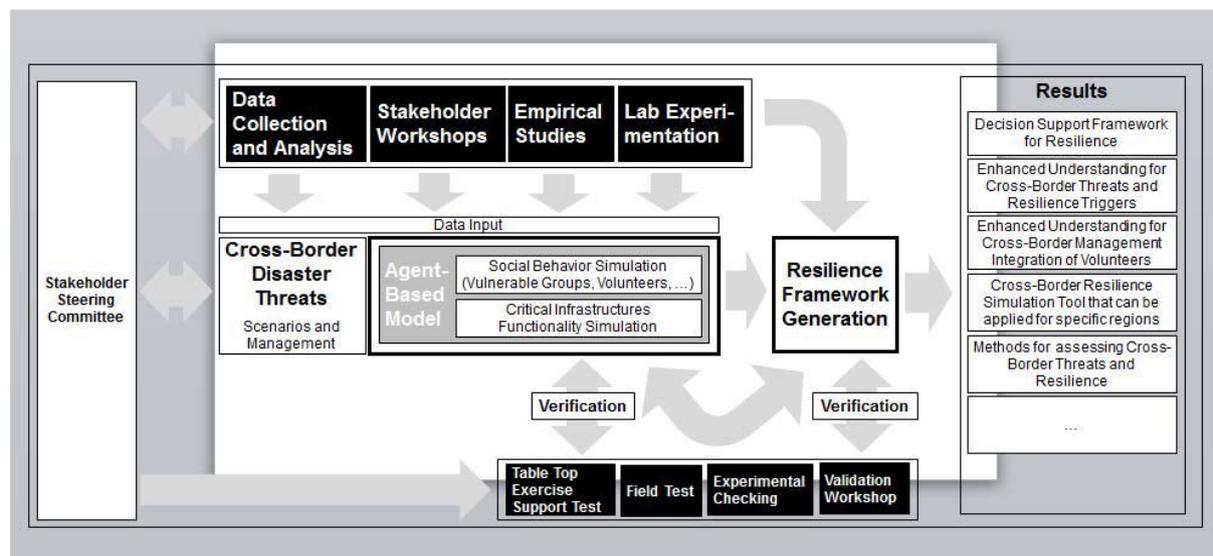


Figure 3: Research framework of the project INCA (Source: Rigaud & Schultmann, 2016, p. 9)

Based on the scenario, data collection and analysis of past events, workshops with stakeholder groups, empirical studies and lab experimentation are used to gain data input for the agent-based model. This model will be used to design and develop the structure of a decision-support system. Accompanying measures are empirical studies of other big parts of the project, medical dependant citizens and voluntary management during cross-border events. To verify the developed features of the decision support system, it will be reviewed iteratively. Therefore, table-top exercises and field tests are planned as well as validation workshops with stakeholders. A triangulation of the results is planned to derive valid results for the transfer into an integrated resilience framework. This framework will provide a decision-support system and will help to enhance the understanding for cross-border threats as well as the integration of volunteers. An own agent-based simulation can be applied for specific regions and scenarios. (Rigaud & Schultmann, 2016)

During the empirical studies on the integration of helping hands of volunteers, different possibilities shall be evaluated for managing these quite new phenomena in crisis management (Rigaud & Schultmann, 2016). Because of the cross-border aspect, there will also be a focus on cultural aspects and differences between

volunteers in Germany and France. At the end of the project, specific recommendations for the implantation of volunteers in different scenarios will be developed. Furthermore, examples of successful common disaster response work among/between authorities and volunteers are used to illustrate the benefit of societal strength in times of disaster. A guideline with recommendations for the integration process will be published for disaster response organisations.

Via identifying the critical points in the information management between Germany and France it shall be outlined where an improvement might be necessary. These improvements can range from tools for translation up to the implementation of already developed IT-support-systems (e.g. project DISASTER, see Cepeda, 2015) or recommendations for changing communication paths.

The description of the medical needs of citizens with medical care/treatment will be implemented in the decision-support-system. This approach will give the decision-makers the possibility to set priorities more easily and receive an overview of the consequences of different alternatives. The needs of the medical dependent citizens will first be outlined for the blackout scenario. But afterwards there will be support for other scenarios as well. Therefore, the needs of citizens will be clustered according the categories electricity, water supply, food supply, etc.

CONCLUSION & PERSPECTIVES

The development of a resilience framework will help the decision-makers before and during cross-border incidents to improve the resilience of these areas. Responsible people can use the guidelines to focus on different scenarios and figure out, which measures are most suitable for their specific problems and areas. Furthermore, the focus on cross-border incidents and the possible impact will hopefully raise the awareness for the difficulties of complex events with different involved countries and stakeholders, especially end-users from the above-defined region (e.g. fire-fighters, paramedics).

It is not the goal of the project to effect changes on the policy level, such as changing laws or the implemented disaster-management structures, but rather improve the communication between the involved end-users and provide tools for faster and more reliable decisions. The decision support system should first of all assist the users to develop their decisions and afterwards share the results with the other involved partners (especially those from other countries), to raise efficiency.

REFERENCES

- Cepeda, M. S. (2015) *Project DISASTER - Final Report*.
- Coste, F., Nexon, E. & Daguzan, J.-F. (2013) *Analysis of Civil Security Systems in Europe: Country Study: France*, Paris.
- European Commission (2015) *France - Disaster management structure: Vademecum - Civil Protection* [WWW document]. URL http://ec.europa.eu/echo/files/civil_protection/vademecum/fr/2-fr-1.html, accessed 20 January 2017.
- European Commission (2016) *Humanitarian Aid and Civil Protection: EU Civil Protection Mechanism* [WWW document]. URL http://ec.europa.eu/echo/what/civil-protection/mechanism_en, accessed 2 January 2017.
- Fahland, D. & Woith, H. (2008) Towards Process Models for Disaster Response. In: *Business Process Management Workshops, International Workshop on Process Management for Highly Dynamic and Pervasive Scenarios (PM4HDPS), co-located with 6th International Conference on Business Process Management (BPM'08)*, pp. 254–265. Springer, Milan, Italy.
- Fathi, R., Schulte, Y., Tonn, C., Gründler, D., Kletti, M. & Spang, A. (2015) *Untersuchung der Modifikationsfaktoren von Spontanhelfern*, Wuppertal/Köln.
- Fernandez, L. S. (2007) *Volunteer management system design and analysis for disaster response and recovery*. Doctoral Thesis, Washington D.C.
- German Federal Office for Civil Protection and Disaster Assistance (2010) *Drei Ebenen, ein Ziel: BEVÖLKERUNGSSCHUTZ - gemeinsame Aufgabe von Bund, Ländern und Kommunen*, Bonn.
- Institute for Major Incidents (2012) *Mémento du maire et des élus locaux: DGv1 – Organisation de la sécurité civile* [WWW document]. URL <http://www.mementodumaire.net/dispositions-generales-2/vigilance-alerte-et-secours/dgv1-organisation-de-la-securite-civile/>, accessed 11 January 2017.
- Leavey, S. (2012) *Mitigating Power Fluctuations from Renewable Energy Sources*, Glasgow.
- Lindemann, C., Prödel, S. & Koch, R. (2010) Modellierung von Prozessen in der Feuerwehrdomäne zur zur Identifikation von Informationsbedarfen. In: *Software engineering 2010: Workshopband (inkl. Doktorandensymposium) ; Fachtagung des GI-Fachbereichs Softwaretechnik ; 22. - 26.02.2010 in Paderborn*. Engels, G. (ed.), pp. 433–441. Ges. für Informatik (GI), Bonn.
- Lotter, A., Brauner, F., Barth, K., Mudimu, O. A. & Lechleuthner, A. (2015) Analysis Of Information Flow In

- Events Caused By Collapsed Building. *International Journal of Civil Mechanical Engineering*, **5** (1), 1–6.
- Lund, H., Andersen, A. N., Østergaard, P. A., Mathiesen, B. V. & Connolly, D. (2012) From electricity smart grids to smart energy systems – A market operation based approach and understanding. *Energy*, **42** (1), 96–102. doi: 10.1016/j.energy.2012.04.003.
- Ministry of Home and Municipal Affairs North Rhine-Westphalia (2014) *Gefahrenabwehr in Nordrhein-Westfalen: Jahresbericht 2013*, Düsseldorf.
- Pappert, T., Starke, M.-U., Brauner, F., Mudimu, O. A. & Lechleuthner, A. (2015) *Event-based decision support systems to improve user-oriented communication of cross-border disaster event*. Presented at the 2015 International Crisis and Risk Communication Conference, Orlando, Florida, USA.
- Petermann, T., Bradke, H., Lüllmann, A., Poetzsch, M. & Riehm, U. (2011) *Was bei einem Blackout geschieht: Folgen eines langandauernden und großflächigen Stromausfalls*. Edition sigma, Berlin.
- Ramakers, M., Bindels, T. & Wellding, J. (2007) *Grenzüberschreitende Hilfeleistung in der Euregio Maas-Rhein: Gesetze und Regelungen, Abkommen und Vereinbarungen zum grenzüberschreitenden Einsatz von medizinischen Rettungsdiensten und Feuerwehren in der Euregio Maas-Rhein*.
- Rigaud, E. & Schultmann, F. (2016) *INCA - Project Description*.
- Rothgang, H., Kalwitzki, T., Müller, R., Runte, R. & Unger, R. (2015) *BARMER GEK Pflegereport 2015: Schwerpunktthema: Pflegen zu Hause*. Asgard-Verl.-Service, Siegburg, Siegburg.
- Thielen, A. H. (ed.) (2015) *Das Hochwasser im Juni 2013: Bewährungsprobe für das Hochwasserrisikomanagement in Deutschland*. DKKV, Bonn.