Natural Hazards (2023) 119:1137–1140
https://doi.org/10.1007/s11069-022-05516-3

ORIGINAL PAPER

Challenges and opportunities using new modalities and technologies for multi-risk management

Benni Thiebes[1] · Ronja Winkhardt-Enz[1]

Received: 13 April 2022 / Accepted: 20 July 2022 / Published online: 9 August 2022
© The Author(s), under exclusive licence to Springer Nature B.V. 2022

Abstract
Recent crisis events and disasters, such as the 2021 flood disaster in Germany highlight the fact, that the management of multi-risks remains a challenge for risk managers and decision-makers even in highly developed countries. Nevertheless, over the past decade, new and innovative methods for data collection, analyses and communication have emerged and are increasingly being utilised in all phases of disaster risk management, e.g., from the domain of earth observation, artificial intelligence (AI) and social media. However, there are still gaps between scientific research, operative civil protection, and political decision-making. These gaps can only be bridged by closer collaboration and exchange.

Keywords Multi-risk management · Disaster risk reduction · New technologies

1 Multi-risk management

Humankind increasingly faces multiple challenges including multi-risks, compounding risks, cascading effects, and rapidly changing environmental and societal conditions that require an effective management approach. Risk management is often classified into the four different phases of prevention, preparedness, response and recovery, and all phases can benefit from novel technologies and data.

In this short communication, some selected novel approaches are discussed along with the risk management phases from the perspective of the German Committee for Disaster Reduction (DKKV), a platform focusing on the facilitating exchange of experts from science, operational practice, administration, policy, and the public, and against the backdrop of the German 2021 flood disaster. This event, which also affected the Netherlands and Belgium, represents the deadliest flood-related disaster in Germany in 60 years with more than 180 fatalities and the costliest with around 30 billion EUR damage (DKKV 2022a).

✉ Benni Thiebes
benni.thiebes@dkkv.org

[1] German Committee for Disaster Reduction (DKKV), Kaiser-Friedrich-Straße 13, 53113 Bonn, Germany

2 Prevention phase

The prevention phase, in which minimizing the effects of disasters, particularly through risk assessment, and impact predictions, can potentially benefit greatly from new technologies and methods. A prime example is the continuous acquisition of new earth observation data to elaborate the temporal and spatial changes of risk components, i.e., hazard, vulnerability, and exposure, that can form the foundation for better-informed decision making. Analysis of such data sets can be more efficient when applying emerging technologies such as big data methods and artificial intelligence (AI) (Kuglitsch et al. 2022). All these data can feed impact models that simulate the effects of hazard scenarios and can provide the basis for evacuation and emergency planning.

Although there is great potential for new modalities and technologies for the prevention phase, they are not yet taken advantage of the full extent. Partly this is due to a lack of exchange between scientific and operative actors during which operative needs and technical solutions can be streamlined.

Risk awareness is another important issue to allow for risk-informed decision-making. Here, new technology can assist public awareness raising and trainings particularly through immersive technologies such as virtual and augmented realities (Itamiya 2021; Caballero & Niguidula 2018).

3 Preparedness phase

The preparedness phase is focusing on planning how to respond to a disastrous event and mitigate damage, and also comprises the forecasting and early warning systems. Forecasts of the 2021 flood events were based on ensemble modelling utilising radar-based rainfall monitoring as well as hydrological models (DKKV 2022a). Early warning and alarm systems can use different channels to disseminate crisis information and evacuation orders. In Germany, warning apps, sirens, and loudspeaker messages from local fire brigades are the most common techniques for warning the population. A major benefit of warning apps is the ability to disseminate various information on imminent hazards including guidelines on how to react. Similarly, social media offer channels for communication and also allow for two-way communication.

However, during the flood event in Germany, electricity and mobile networks failed in many areas so that no information could be distributed. Additionally, not everyone uses warning apps. The age distribution of fatalities in the particularly affected Ahr valley shows that approximately 80% of all deaths were in the age group of 60 years and older (DKKV 2022b). This age group generally has a lower usage of smartphones than younger people and is thus less likely to receive warnings. As a consequence of the flood, Germany has now changed its warning and alarming strategy. Sirens, which were to large extent removed since the end of the cold war are now being reinstalled and cell broadcasts are to be implemented, although technical challenges remain.

4 Response phase

The ever-increasing role of social media in the response phase cannot be denied. This is how volunteers and spontaneous helpers organise themselves and at the same time there is also the risk of fake news getting into circulation. New technologies, methods and tools can support an efficient response mechanism. Nonetheless, new technology is mostly dependent on a secure power supply, internet, or network connection. So, in the case of a disaster-related blackout, it is important to use redundant methods and tools for the response phase. If these conditions are met, new technologies can help, especially in organisation and logistics, but also in the procurement of an overview through constant site plan monitoring. During the flood disaster in Germany, social media were also instrumental in getting information on the flood levels, its damage impacts, as well as on people in need of assistance.

Damage information and needs for assistance were also fostered by earth observation data from various actors. These include, for instance, damage reports and estimates by the COPERNICUS emergency service (Nereus 2018), image acquisitions by DLR (DLR 2022a, 2022b) as well the German forces (Bundeswehr 2022). Additionally, information was also collected by UAVs being employed by aid organisations, local fire brigades and DLR (DLR 2021), as well as private citizens who wanted to contribute to the creating a better overall crisis mapping in the disaster situation.

5 Recovery phase

The overarching goal of the recovery phase is to 'build back better' (UNDRR 2015) in order to not recreate the situation that led to the disaster in the first place. Here, detailed investigations of how the disaster unfolded need to be carried out. At the same time, risk-mitigating activities related to the prevention phase need to be employed to close the cycle. Again, risk-assessments and awareness-raising activities play a crucial role and new modalities, and technologies can contribute immensely.

6 Conclusions for future challenges

Overall, new modalities and technologies offer the possibility to greatly the management of multi-risks, however, they do not automatically contribute to reduced losses in a disaster event. Creating disaster-resilient societies is not a challenge to which technology can provide the only solution as these also have limitations that need to be discussed openly. Although emerging technologies and data can contribute immensely to a better management of multi-risks, these can only represent one building block in the larger frame of resilience building. It is crucial that scientific experts developing and exploiting new technologies are doing so in close cooperation with operation forces to match demand and supply. Additionally, the policy level needs to be involved to create the conditions where more effective approaches are not only allowed for but explicitly requested and supported. Thus, exchange between science, practice, and policy needs to be fostered.

Authors' contributions All authors contributed to the manuscript.

Funding The authors have not disclosed any funding.

Declarations

Conflict of interest The authors have not disclosed any competing interests.

References

Bundeswehr (2022). Zwischenstand: die bundeswehr im hochwasser-katastropheneinsatz 2021. Online available: https://www.bundeswehr.de/de/aktuelles/meldungen/zwischenstand-bundeswehr-hochwasser-katastropheneinsatz-2021-5209064. Accessed on: 11.04.2022

Caballero A R, & Niguidula J D (2018) Disaster risk management and emergency preparedness: a case-driven training simulation using immersive virtual reality. In Proceedings of the 4th international conference on human-computer interaction and user experience in Indonesia, CHIuXiD'18 (pp. 31–37).

DKKV (2022a): Die Flutkatastrophe im Juli 2021. Ein Jahr danach: Aufarbeitung und erste Lehren für die Zukunft. DKKV-Schriftenreihe Nr. 62, Bonn. ISBN: 978-3-933181-72-5. https://www.dkkv.org/fileadmin/user_upload/Flutkatastrophe/DKKV_Schriftenreihe_Ausgabe_62.pdf (last accessed August 9, 2022)

DKKV (2022b). Opfer- und Schadensdaten zur Flut 2021 in Rheinland-Pfalz. DKKV Datenaufbereitung auf basis der daten der aufsichts- und dienstleistungsdirektion (ADD) Rheinland-Pfalz sowie vom Landesamt für Soziales, Jugend und Versorgung Rheinland-Pfalz (LSJV - RLP)

DLR (2022a). DLR erfasst Schadenslage nach der flutkatastrophe. online available: https://www.dlr.de/content/de/artikel/news/2021/03/20210726_dlr-erfasst-schadenslage-nach-der-flutkatastrophe.html. Accessed on: 11.04.2022a

DLR (2022b). Lageinformationen für Rettungskräfte. online available: https://www.dlr.de/content/de/artikel/news/2021/03/20210716_lageinformationen-fuer-die-rettungskraefte.html. Accessed on: 11.04.2022b

DLR (2021). Unwetter in Nordrhein-Westfalen und Rheinland-Pfalz, Deutschland. Online available: https://activations.zki.dlr.de/de/activations/items/ACT152.html. Accessed on: 11.04.2022

Itamiya T (2021) VR/AR and its application to disaster risk reduction. In: Sakurai M, Shaw R (eds) Emerging technologies for disaster resilience. disaster risk reduction. Springer, Singapore. https://doi.org/10.1007/978-981-16-0360-0_5

Kuglitsch M et al (2022). Artificial intelligence for disaster risk reduction: opportunities, challenges, and prospects. Bulletin nº, 71, 1. Online available: https://public.wmo.int/en/resources/bulletin/artificial-intelligence-disaster-risk-reduction-opportunities-challenges-and. Accessed on: 11.04.2022

NEREUS, European space agency and european commission (2018). The Ever Growing use of copernicus across Europe's Regions: a selection of 99 user stories by local and regional authorities. Online available: https://esamultimedia.esa.int/docs/EarthObservation/copernicus4regions_2018.pdf. Accessed on: 11.04.2022

UNDRR (2015). Sendai framework for disaster risk reduction 2015–2030. https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf. Accessed 25 May 2022

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Springer Nature or its licensor holds exclusive rights to this article under a publishing agreement with the author(s) or other rightsholder(s); author self-archiving of the accepted manuscript version of this article is solely governed by the terms of such publishing agreement and applicable law.