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Call for Papers for a Special Issue of *Risk Analysis*

Integration of risk warning and emergency response to extreme disasters: The role of emerging technologies

Background and Focus:

Extreme disasters occur more frequently with the evolution of global risk society and increasing uncertainty of environments. For example, climate change, increasingly extreme weather and seismic events have caused a surge in severely damaging disruptions to communities exposed to natural hazards over the past 50 years (WMO, 2023). The records of the past 40-50 years show that the long-term average number of major earthquakes has exceeded that predicted by long-term records since 1900 about a dozen times (USGS, 2023). The research during COVID-19 also reminds the world to be ready to respond to next pandemic (WHO, 2023).

Extreme events triggered by natural hazards create not only a surge in immediate demands for assistance and support to the affected communities, but also generate cascading effects that lead to unpredictable consequences. This difficult, dynamic set of conditions creates an imperative to develop Adaptive Emergency Management (AEM), a new framework in addition to Comprehensive Emergency Management (CEM). The AEM extends the concepts and methods advanced in the literature on Complex Adaptive Systems (CAS) (Comfort, 1999; Comfort, 2019; Holland, 1996) by highlighting the simultaneous learning capacity in the stage of response to meet ever-changing demands and to interrupt cascading effects at the very initial stage of extreme events (Comfort, Haase, Ertan, & Scheinert, 2020; Comfort & Zhang, 2020; Hodges & Larra, 2021; Zhang, Dai & Qian et al., 2022; Tao & Zhang, 2023).

Risk warning, in association with other core functions of risk governance such as risk identification, risk perception, risk analysis, risk evaluation, and risk communication (Renn, 2008; Aven and Renn, 2012; Aven and Zio, 2012; Aven, 2023; Cox, 2023; National Academies, 2018), is globally regarded as preferable to focusing on response strategies to prevent and reduce losses of human lives and property caused by extreme events (UN, 2022). In past decades, various risk warning systems have been developed to deal with specific types of extreme events, such as a hurricane forecast and warning system, earthquake early warning system, tsunami early detection and warning system, and wildfire prediction and early warning system (Paté-Cornell, 1986; Wang & Li, 2008; Comfort and Rahayu, 2023; Tylor, Summers & Domingos et al., 2023; Tupper & Fearnley, 2023). In addition, more frequent occurrences of single types of extreme hazards increase the incidence of compound disasters and demonstrate the necessity to develop the Comprehensive Risk Warning (CRW) as a new paradigm to accommodate the coupling effects of multiple hazards and ensuing disasters. As a result, integration of risk warning and emergency response has become a central issue in adaptation to the marked increase in extreme events from natural hazards and the consequent disruption in social and economic activity in the damaged communities that result in disaster.

Emerging technologies, such as artificial intelligence (AI), machine learning (ML), digital twins, block-chain, and cloud computing, play an increasingly pivotal role in facilitating integration of risk warning and emergency response. For instance, by leveraging sensors, AI-based forecasting and nowcasting technologies, certain hazard risks can be identified and analyzed in their early stages, enabling effective mitigation measures and response task forces. Digital twins and real-time simulations offer insights into different scenarios, facilitating dynamic monitoring and rapid decision-

making. Additionally, the widespread use of GPS, smartphones, and social media empowers crowd-based risk identification, communication, self-organization and crowdsourcing, bolstering the collective capacity to be aware of, and respond to, acute situations. Knowledge mapping, chatbots, and natural language processing (NLP) are also employed to distill insights and lessons from historical events, thereby promoting effective learning among communities and organizations in early warning and adaptive response at the initial stage of extreme disasters.

However, as emerging technologies are rapidly adopted in risk warning and emergency response, a comprehensive understanding of this phenomenon from a socio-technical perspective becomes imperative (Comfort, 1999; Comfort, Haase, Ertan, & Scheinert, 2020; Comfort & Zhang, 2020; Cox, 2023; Aven, 2023). Development and integration of risk warning and emergency response not only hinges on technological advancements but also on the effective embeddedness of these technologies into social systems. The inception and design of technological systems must be harmonized with human values and societal factors. Moreover, the successful operation, evaluation, regulation, and improvement of technological systems require insights from risk science, including social, institutional, organizational, and psychological perspectives (Beck, 1995; Tierney, 2014).

Collaborative studies encompassing multiple disciplines such as social sciences, information sciences, engineering, must address critical questions before intelligent platforms/systems proliferate and gain trust within the realm of risk governance and emergency management (Ansell and Torfing, 2016). A series of new questions need to be addressed. For example, how do early warning technologies address uncertainties in disaster risk communication and influence human decision making? How do AI/ML assist in real-time risk assessment and forecasting during emergency response? How are risk perceptions of individuals, communities, and other stakeholders considered in the development of such technologies? Lastly, how can social dynamics be seamlessly integrated with physical data to enhance situational awareness and decision-making processes in disaster risk governance?

Topics of interest include but are not limited to:

- Challenges and opportunities of using emerging technologies in risk identification, risk perception, risk analysis, risk assessment, risk communication, and risk warning
- New theories and methodologies for applying risk warning to specific hazards and comprehensive risk warning to multiple hazards in the digital era.
- Case studies and comparative case studies on practices of integration of risk warning and emergency response empowered by emerging technologies in various social contexts.
- Modeling and simulation for integration of physical and social data in achieving comprehensive risk warning and adaptive emergency response
- Inter-organizational collaborations and crowdsourcing and collective intelligence supported by emerging technologies in risk warning and emergency response
- Human-machine interaction and AI-based decision support in risk warning and emergency response
- Governance of ethical and social risks in using emerging technologies for risk warning and emergency response

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Proposed timeline:

- **May 31, 2024** - Deadline for receiving submissions
- December 2024 - Finish reviews

• Early 2025 - Special issue published

References:

Ansell, C. and Torfing, J. (2016). *Handbook on Theories of Governance*. Edward Elgar.

Aven, T., Renn, O.(2012). On the risk management and risk governance of petroleum operations in the Barents Sea Area. *Risk Analysis*. 32(9), 1561-1575.

Aven, T., & Zio, E. (2012). Foundational issues in risk assessment and risk management. *Risk Analysis*, 32(10), 1647-1656.

Aven, T. (2023). Risk literacy: Foundational issues and its connection to risk science. *Risk Analysis*, https://doi.org/10.1111/risa.14223.

Beck, U. (1995). *Ecological Enlightenment: Essays on the Politics of the Risk Society*. Atlantic Highlands, NJ: Humanities Press.

Comfort, L. K. (1999). *Shared Risk: Complex Systems in Seismic Response*. Pergamon Press.

Comfort, L.K. (2019). *The Dynamics of Risk: Changing Technologies and Collective Action in Seismic Events*. Princeton University Press.

Comfort, L. K., Haase, T. W., Ertan, G., & Scheinert, S. R. (2020). The Dynamics of Change Following Extreme Events: Transition, Scale, and Adaptation in Systems Under Stress. *Administration & Society, 52*(6), 827-861. doi:10.1177/0095399719869991

Comfort, L. K., & Zhang, H. (2020). Operational Networks: Adaptation to Extreme Events in China. *Risk Analysis, 40*(5), 981-1000. doi:https://doi.org/10.1111/risa.13442

Comfort, L.K. and Rahayu, H.P., Eds. (2023). *Hazardous Seas: A Sociotechnical Framework for Early Tsunami Detection and Warning*. Washington, DC: Island Press.

Cox Jr., L.A. (2023). *AI-ML for Decision and Risk Analysis : Challenges and Opportunities for Normative Decision Theory*, Springer Cham.

Hodges, L. R., & Larra, M. D. (2021). Emergency management as a complex adaptive system. *J Bus Contin Emer Plan, 14*(4), 354-368.

Holland, J. H. (1996). *Hidden order: how adaptation builds complexity*: Addison Wesley Longman Publishing Co., Inc.

National Academies of Sciences, Engineering, and Medicine. 2018. *Emergency Alert and Warning Systems: Current Knowledge and Future Research Directions*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24935.

Paté-Cornell, M.E. (1986). Warning system in risk management. *Risk Analysis, 6(2), 223-234.*

Renn, O. (2008). *Risk Governance: Coping with Uncertainty in a Complex World*. London, Routledge.

Tao, Z., & Zhang, H. (2023). The emergence of complex adaptive response networks in China: A case study of four disasters. *Risk Analysis*, 1–18. https://doi.org/10.1111/risa.14121

UN. (2002). Early Warning Systems Must Protect Everyone Within Five Years, March 23, https://unfccc.int/news/un-early-warning-systems-must-protect-everyone-within-five-years

Tierney K. (2014). *The Social Roots of Risk: Producing Disasters, Promoting resilience*. Palo Alto, CA: Stanford University Press.

Tupper, A.C., Fearnley, C.J. (2023). Disaster early-warning systems can succeed — but collective action is needed, *Nature*, November 15,https://www.nature.com/articles/d41586-023-03510-8

Tylor, A., Summers, B., & Domingos, S., et al. (2023). The effect of likelihood and impact information on public response to severe weather warnings. *Risk Analysis*, https://doi.org/10.1111/risa.14222.

Wang, J.F., & Li, L.F. (2008). Improving Tsunami Warning Systems with Remote Sensing and Geographical Information System Input. *Risk Analysis*, 28(6), 1653-1668.

Zhang, H. B., Dai, X. Y. & Qian, D. P. et al. (2022). Strategic perspective of leveraging new generation information technology to enable modernization of emergency management. *Bulletin of Chinese Academy of Sciences*, 37(12): 1727-1737. (in Chinese)