International Journal of Disaster Risk Science (2025) 16:521–523
https://doi.org/10.1007/s13753-025-00662-1

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EDITORIAL

Editorial Introduction to the Special Issue on Polycrisis and Systemic Risks

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Accepted: 1 August 2025 / Published online: 9 September 2025

The world is increasingly confronted with overlapping, interconnected crises—termed *polycrises*—which mutually reinforce each other and cause damage far exceeding the sum of their parts. These interconnected crises are often a product of systemic risks that challenge conventional, linear cause-effect models and demand new integrative, inter- and transdisciplinary approaches to risk analysis, governance, and communication. Understanding such crises requires a systemic view of natural, technological, social, and cultural dynamics, emphasizing interdependence, complexity, and inclusivity.

This special issue of the *International Journal for Disaster Risk Science* provides such a systematic review of the field. Most contributions originated from the 2024 International Symposium on Systemic Risk and Polycrisis Governance, co-hosted by Beijing Normal University and the International Institute for Applied Systems Analysis (IIASA) in 9–10 May, Beijing, China. The International Symposium brought together global experts to address key requirements for assessing, managing, and communicating polycrisis. This includes the governance of cascading risks and the resolution of conflicting goals to fostering ethical trade-offs, transparent communication, and stakeholder involvement and engagement. By uniting diverse risk research communities, the symposium laid the foundation for improved policy responses to future systemic challenges.

This special issue showcases valuable contributions that offer fresh insights into today's increasingly interconnected world. Highlighting the potential of inter- and transdisciplinary approaches, the articles advance systemic risk analysis, governance, communication, and stakeholder engagement. Together, they introduce innovative methods, compelling case studies, and constructive policy recommendations that enhance our ability to understand and effectively manage cascading systemic risks.

The issue is introduced by a foreword by Hans Joachim Schellnhuber, Director General, IIASA. In his opening remarks the author emphasizes the need for more attention to the problems and for more international cooperation.

The first research article of the special issue addresses the conceptual foundations of the two key terms: polycrisis and systemic risks. This review article by Huan Liu and Ortwin Renn: *Polycrisis and Systemic Risk: Assessment, Governance, and Communication* highlights the shift from isolated risk analysis to the study of interconnected, cascading crises that threaten the stability and functioning of entire systems. By comparing and synthesizing both concepts, the authors propose a unified framework that links the dynamics of polycrisis with systemic risk theory. The review outlines the implications of this integrated perspective for risk assessment, governance, and communication across diverse audiences.

On a more normative level of analysis, Benjamin Hofbauer, Paul Einhäupl, Stefan Hochrainer-Stigler, Jana Löhrlein, Daniel Bittner, and Pia-Johanna Schweizer explore the controversial issue of social justice in their contribution: *Just Systems or Justice in Systems? Exploring the Ethical Implications of Systemic Resilience in Local Climate Adaptation.* The authors critically examine the concept of systemic resilience in local climate adaptation, arguing that it must be understood not only technically but also ethically. The authors highlight that resilience decisions inherently involve normative judgments about what functions should be preserved and for whom, requiring attention to different forms of justice—participatory, procedural, distributive, and historical. Drawing on complexity science, they apply an ethically informed resilience framework to a case study

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in the Rhine-Erft catchment in Germany. The article calls for integrating ethical reflection into resilience planning to ensure fairness and legitimacy in responses to systemic climate risks.

Another perspective on polycrisis lies on the tension between the local and the global implications of polycrisis. Norio Okada and Ortwin Renn present in their article: *Coping with Persistent Disruptive Stressors and Polycrisis: Community-Based Policy Making and Local Empowerment* a conceptual framework for governing systemic risks and polycrises by emphasizing inclusive, community-based policymaking. Their approach centers on the "risk governance triangle," which links persistent disruptive stressors, risk-absorbing systems, and contextual factors. Using the Pagoda model, they structure risk contexts into five interrelated layers, from natural conditions to individual behavior. The authors argue that strengthening local empowerment and deliberative engagement is essential for building resilient, adaptive governance systems in the face of complex, interconnected risks.

As much as polycrisis emphasizes the destructive potential for all goods that humans value, it may also include potential for opportunities to identify the most significant triggers that could improve the present situation. This position is being taken by Reinhard Mechler, Piotr Żebrowski, Romain Clercq-Roques, Patik Patil, and Stefan Hochrainer-Stigler: *Positive Externalities in the Polycrisis: Effectively Addressing Disaster and Climate Risks for Generating Multiple Resilience Dividends.* The authors explore the concept of the Triple Resilience Dividend (TDR), which highlights not only risk reduction benefits but also development and co-benefits arising from disaster risk reduction (DRR) and climate change adaptation (CCA) interventions. Despite recognition of these multiple dividends, systemic underinvestment persists, partly due to limited conceptual clarity and awareness of positive externalities. By reviewing empirical and modeling evidence, the study argues that better integration of systemic risk research with resilience dividend frameworks can improve decision making across scales. Enhanced understanding of these interrelated benefits may foster more comprehensive risk governance crucial for addressing polycrisis challenges.

The next section of the special issue includes six contributions that explore different applications or case studies that demonstrate the properties and problems of polycrisis and offer some suggestion or experiences of how to resolve these challenges. The first contribution in this section starts with an article by Aleksandar S. Jovanović: *Stress-Testing the Resilience of Critical Infrastructures Exposed to Polycrises Triggered by Emerging Risks*. The author presents a novel stress-testing approach to evaluate the resilience of critical infrastructures against extreme threats (XTs), including polycrises and disasters. The method uses resilience indicators addressing both threat characteristics and asset vulnerabilities across the resilience cycle phases, that is, risk analysis, preparation, absorption, recovery, and adaptation. Building on prior EU project work and standards, it integrates recent advances such as the EU Critical Entities Resilience Directive and AI applications. This approach advances resilience assessment by considering systemic risks, complexity, and cascading effects in infrastructure stress testing.

The second article in this section by Penghui Li, Chunyang He, Qingxu Huang, Yida Wang, and Yixuan Zhao: *Spillover of Water Scarcity Risk through Virtual Water Trade in Rapidly Urbanizing Drylands* investigates how virtual water trade contributes to the spillover of water scarcity risks in rapidly urbanizing drylands, using the HBOY urban agglomeration in China as a case study. By integrating multi-regional input-output modeling with structural path analysis, the authors trace how over 90% of HBOY's water scarcity burden is transferred to already water-stressed regions, particularly Inner Mongolia and Ningxia. Key transmission paths run through agriculture, light industry, and construction, with significant impacts on external agricultural sectors. The authors advocate for coordinated cross-regional water management to address these hidden but critical vulnerabilities in water-scarce urban development.

The third study in this section by Xinyu Jiang, Dan Lai, Lijiao Yang, Xinyi Lei, and Si Ha: *Assessing Ripple Effects of Production Capacity Loss from Compound Hazards: A Case Study of Flood and COVID-19 in Enshi, Hubei Province* develops a supply-side framework to assess the economic ripple effects of compound hazards, using the 2020 flood in Enshi, China, during the COVID-19 pandemic as a case study. By combining on-site surveys, urban travel intensity data, and a mixed multi-regional input-output model, the authors disentangle the relative contributions of each hazard. Results show that ripple effects exceeded direct losses, with the flood responsible for a greater share of disruptions than the pandemic. The findings underscore the differential vulnerability of regions and sectors and demonstrate the value of integrating empirical and big data sources for compound risk analysis.

The fourth contribution stems from Feng Yu, Chen Yao, Chaoxiong Dengzheng, Qing Deng, and Xiangyang Li: *A City-Level Integrated Case Base Design for Systemic Disaster Risk Management.* The authors introduce a novel, city-level case base designed to enhance case-based reasoning (CBR) for managing urban systemic risks. Addressing the limitations of existing case bases, the proposed system features a nested cross structure with a vertical dimension (environment–hazard–object–aftermath) and a horizontal dimension (network–chain–pair) to capture complex risk scenarios and associations. Hazard functions as a central connector between these dimensions, enabling more precise and adaptive reasoning. The approach supports digital transformation

in urban risk governance and aims to strengthen decision-making capacities under time constraints.

The fifth contribution in this section is written by Christopher Yan-Chak Chan, Giuseppe Dal Prá, Isabel Johnson, Matt Boyd, and Ram Eirik Glomseth. The article is entitled: *Resilience Reconsidered: The Need for Modeling Resilience in Food Distribution and Trade Relations in Post Nuclear War Recovery.* The authors argue for greater attention to recovery and resilience in the aftermath of nuclear war, particularly with respect to global food distribution and trade networks. The authors highlight that even limited nuclear exchanges could disrupt key infrastructure and supply chains and trigger famine and compounding global vulnerabilities. The findings call for inclusion of nuclear resilience in global scientific assessments and emphasize that lessons from reduced sunlight scenarios are relevant to multiple catastrophic risks.

Finally in this section, the study by Anil Kumar, Indrajit Pal, Djoen San Santoso, Sarawut Ninsawat, and Sheikh Tawhidul Islam: *Identification of Critical Infrastructure Sectors and Their Interdependencies in Bangladesh: A Step Towards Resilience Planning* identifies critical infrastructure sectors and their interdependencies in Bangladesh as a foundation for resilience planning in the context of the country's goal to become a high-income economy by 2041. Using expert validation, interpretive structural modeling, and MICMAC analysis, the authors map out 14 key sectors—such as energy, ICT, and transportation—and assess their systemic roles. The findings highlight which infrastructures exert strong influence and which are highly dependent, informing strategic prioritization under resource constraints. The study offers targeted policy recommendations to strengthen institutional capacities and infrastructure resilience in a developing country context.

The special issue ends with two commentaries by two participants of the 2024 symposium, who reflect about the present challenges and provide potential conceptual and methodological advice for the academic as well as the policymaking communities. Ruth Richardson's commentary addresses the urgent need to respond to polycrisis—through a systemic risk lens. In response to the new challenges, the Accelerator for Systemic Risk Assessment (ASRA) promotes a new paradigm combining systemic thinking, inclusive methodologies, and practical tools to improve risk governance across sectors and scales. ASRA's approach emphasizes ethical responsibility, long-term foresight, and adaptive capacity to support more resilient and equitable futures. The comment by M. Granger Morgan reflects on the limitations of conventional risk frameworks when applied to systemic risks and polycrisis, highlighting the need for more dynamic models that account for feedbacks, complexity, and deep uncertainty. Central to the paper is a call for rigorous expert elicitation methods to inform risk assessment in the absence of sufficient empirical data. Drawing on decades of applied work, Morgan emphasizes that expert elicitation is not a shortcut but a demanding process requiring careful protocol design, iterative testing, and awareness of overconfidence and cognitive biases. He concludes that, while expert judgment can be invaluable, its credibility hinges on methodological integrity and appropriate application.

This special issue presents a comprehensive and interdisciplinary collection of scholarly articles that offer a state-of-the-art overview of key concepts, analytical methods, and practical applications related to polycrisis and systemic risks. To our knowledge, it is the first thematic issue in a scientific journal dedicated entirely to this emerging and urgent field. As such, it aims to pioneer further academic inquiry while also drawing greater attention from policymakers, the private sector, and civil society. Beyond advancing knowledge, the issue seeks to foster international collaboration by bridging the gap between scientific expertise and decision making in both public and private domains. At a time when the world faces escalating global challenges, what is needed is not more geopolitical fragmentation, but coordinated, evidence-based action to develop resilient and widely acceptable solutions. The editors hope that the insights compiled in this issue will stimulate meaningful international dialogue and encourage innovative responses to the complex realities of polycrisis and systemic risk.