

The Impact of Crises on Critical Infrastructure "Crises@KRITIS"

Conference report on the international conference of the Research Training Group KRITIS, Technical University of Darmstadt held on the 26th September 2024

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Introduction

The "Impact of Crises on Critical Infrastructures" conference, held on September 26, 2024, at the Georg-Christoph-Lichtenberg-Haus in Darmstadt, Germany, brought together a diverse group of academics, policymakers, and practitioners to examine the impacts of crises on critical infrastructure (CI). Organized by the KRITIS Research Training Group, the conference aimed to foster interdisciplinary dialogue and address the complex socio-technical challenges posed by crises such as pandemics, wars, climate change, and technological failures.

At its core, the conference explored how crises act as stress tests for critical infrastructures, revealing vulnerabilities and driving transformation. Central themes included the concepts of vulnerability, trust, and transformation—three pillars that underpin infrastructures' ability to adapt and evolve in response to crises.

The event highlighted the importance of interdisciplinary approaches in understanding the intricate dynamics of crises by bringing together experts from fields such as philosophy, engineering, political science, sociology, history, and urban planning. Contributions ranged from theoretical analyses to empirical studies, emphasizing immediate responses to crises and long-term strategies for resilience and disaster management. The conference also sought to redefine the role of critical infrastructure in modern society as a means of maintaining stability and as a driver of transformation and innovation.

Keynotes

The conference featured two keynote addresses, setting the stage for discussing the relationship between crises and critical infrastructure.

In her keynote, "Societies in Times of Crisis: Do Infrastructures Provide Comfort or Amplify Vulnerability?" PD Dr. Anna-Lisa Müller of Bielefeld University explored the dual role of infrastructure during crises. Using empirical data from the COVID-19 pandemic, Müller illustrated how infrastructures can alleviate and exacerbate vulnerabilities. She highlighted that infrastructures provide comfort by enabling adaptive practices and maintaining societal functions but can also amplify vulnerability by exposing systemic inadequacies and fostering uncertainties. Müller's analysis emphasized that infrastructures are deeply intertwined with societal norms, spatial configurations, and material practices. The talk encouraged critical reflection on how social and material infrastructures shape everyday life during crises.

The second keynote, "Critical Infrastructure Resilience: Complexity and Governance," was delivered by German Federal Office of Civil Protection and Disaster Assistance (BBK) representative and KRITIS alumna Dr. Eva-Katharina Platzer. The presentation provided an in-depth overview of Germany's critical infrastructure protection framework, grounded in the "all-hazards approach." Emphasizing the role of integrated governance and the newly adopted EU Directive 2022/2557 on resilience, the keynote addressed the complexities of balancing federal, state, and municipal responsibilities. It also underscored the importance of public-private collaboration, robust legal frameworks, and innovative risk assessment tools to enhance resilience. The BBK's focus on flexibility and adaptability within governance structures offered valuable insights into managing CI in an era of increasingly unpredictable conditions.

Panel 1: Habits and Crises

The first panel session delved into how individual and collective behaviors intersect with critical infrastructure resilience during crises.

The presentation "Food Emergency Preparedness for Critical **Infrastructure** Crises in Germany" by Katharina Eberhardt, Sonja Rosenberg, and Frank Schultmann examined the role of private food stockpiling in disaster scenarios. The empirical study highlighted how household behaviors, influenced by urban or rural settings and family size, are crucial in ensuring community resilience. The findings emphasize the importance of public awareness campaigns and government measures to encourage stockpiling of essential food items to complement centralized disaster response strategies.

Aljoscha Mayer's contribution, "Organization and Coordination of Spontaneous Volunteers in Disaster Relief," explored the role of volunteers in the 2023 Kahramanmaraş earthquake in Turkey. Mayer highlighted the transformative potential of spontaneous volunteers in creating adaptive and innovative disaster responses. The study underscored the necessity of improving coordination between formal disaster relief organizations and informal volunteer networks to enhance the effectiveness and inclusiveness of disaster management systems.

In "A BRIC Portrait of the Netherlands," Tony Wei-Tse Hung and Theresa Audrey O. Esteban applied the Baseline Resilience Indicators for Communities (BRIC) framework to assess neighborhood-level resilience in the Netherlands. Using over 50 variables tailored to local conditions, the research identified spatial patterns of resilience and areas requiring targeted interventions. The study offered a comprehensive look at how urban resilience can be systematically analyzed to inform policy and planning.

Panel 2: Trust and Crisis

This session explored how crises challenge the dynamics of trust and governance in critical infrastructure systems.

"Urban Vulnerability to Outer Space Events," presented by Ulpia-Elena Botezatu, highlighted the impact of space-weather-induced phenomena like solar storms on urban infrastructure. Drawing parallels between the Carrington Event of 1859 and the Northeast Blackout of 2003, the study emphasized the critical need for advanced predictive tools and adaptive measures to protect urban centers' electrical grids and communication networks.

Hagen Braun's "AI Trust and the Black Box Problem" addressed the ethical complexities surrounding trust in AI systems. Braun argued that while algorithmic transparency is often impractical due to AI's complexity, transparency about developers' motivations and methods is essential for fostering well-placed trust. This nuanced perspective challenges conventional views on AI trustworthiness and emphasizes the role of human accountability in AI governance.

Jurgena Kamberaj's presentation, "Critical Infrastructure Resilience: Lessons from Ukraine," examined how Ukraine maintained its CI's functionality amid war challenges. By analyzing legislative developments, decentralization efforts, and international aid during the Russian invasion, the study offered a detailed account of the factors contributing to CI resilience. Case studies on energy, transportation, and communication sectors provided actionable insights into building robust and adaptable systems.

Panel 3: Criticality and Crisis

The final session focused on historical and contemporary perspectives on the criticality of infrastructure during crises.

Letizia Curreri's study, "Dangerous Waters: Crisis Impact on Navigation Infrastructure in the Middle Ages," examined the role of ships as mobile critical infrastructure during medieval maritime crises. By analyzing sociopolitical dynamics and the resilience of port cities like Rhodes, the research offered a historical lens to understand the interplay of mobility, security, and infrastructure during times of conflict.

In "Crisis, Criticality, and Compromise: Securing Infrastructure Against Natural Disasters Since 1945," Julia Mariko Jacoby explored Japan's infrastructural evolution post-WWII. The study highlighted how natural disaster vulnerability influenced Japan's systematic investments in CI, such as seawalls and earthquake-resistant construction. Jacoby emphasized the compromises inherent in balancing public trust and resource constraints, shedding light on long-term trends in disaster management.

"Simulation Building Blocks for Predicting Critical System Changes" by Jacopo Bonari, Marco Mattuschka, Max von Danwitz and Alexander Popp introduced cutting-edge methods for creating digital twins of Cl. By integrating high-fidelity simulations, physics-informed machine learning, and virtual sensing, the research demonstrated the potential of predictive tools to enhance real-time decision-making and resilience in Cl systems.

Conclusion

"The Impact of Crises on Critical Infrastructure" international conference underscored the intricate relationship between crises and critical infrastructures, highlighting their vulnerabilities and transformative potential. Through interdisciplinary discussions, the event provided valuable insights into how socio-technical systems can adapt to challenges posed by natural disasters, technological disruptions, and geopolitical conflicts.

One insight emphasized in many sessions was the importance of adaptive and inclusive governance. Contributions highlighted how decentralization, public-private collaboration, and localized solutions play critical roles in mitigating the effects of crises. At the same time, the use of cutting-edge technologies like AI and digital twins showcased the potential of innovation to improve preparedness and decision-making while raising important questions about accountability and transparency.

Historical perspectives added depth to the discussions, revealing how past societies navigated crises and built resilience through resourceful approaches and compromise. These lessons remain relevant today, emphasizing the need for flexibility, equity, and collaboration in shaping future infrastructure policies.

As the world faces increasingly complex and interconnected crises, the insights shared at the conference are timely and essential. The conference contributed to the discussion on developing more resilient and equitable infrastructure systems to sustain society through uncertainty and change by fostering dialogue and knowledge exchange across disciplines.