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TRACK: Complex Adaptive Social Systems and Natural Hazard Resilience: Application, Methods, and Future Directions

International Conference on Resilient Systems

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INTRODUCTION TO THE TRACK

This track aims to foster transdisciplinary (and ambitiously undisciplinary) dialogue to develop actionable insights on how the lens, language, and methods of Complex Adaptive Systems (CAS) theory can advance understanding of disaster dynamics and resilience in socio-technical systems.

Society as a Complex Adaptive System (CAS) is not a new notion, nor is the assumption that natural hazard-induced disaster is a state of society under stress that may self-organize into a novel system configuration around a new attractor, with resilience emerging from the system's adaptive dynamics. However, a setting in which the two can meaningfully coexist has not yet been developed. While the past decade has seen major progress in operationalizing resilience in disaster studies, the potential of CAS theory and its associated methods in this domain remains significantly underexplored.

CAS offers a versatile transdisciplinary framework for understanding dynamic phenomena arising from the non-linear exchanges of energy, matter, and/or information among heterogeneous agents with an internally encoded representation of their environment. CAS theory provides a powerful, innovative lens that allows for new dimensions in which microscopic and macroscopic system dynamics and behaviors can be understood and causalities and nexuses identified. The truly systemic, holistic view of CAS theory, along with the universality of its principles and methods across diverse domains, offers a valuable capacity for understanding disaster resilience dynamics and designing interventions to effectively and efficiently facilitate resilience formation in social systems.







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TRACK TOPICS

Topic 1) Methods and approaches for the application of CAS in climate change and natural hazard-induced disaster resilience research.

This topic engages with computational and analytical methods and methodologies that facilitate the application of CAS theory in disaster resilience, such as System Dynamics (SD) modeling, Network Analysis, Agent-based Modeling, Bayesian Belief Networks (BBNs), Percolation theory, Digital Twins, Machine Learning, Evolutionary Game Theory, Causal Inference Methods, Cross-Impact Balance Analysis (CIB), Graph Neural Networks (GNNs), Nonlinear Time Series Analysis, and hybrid modelling approaches in order to

- Model agent-environment-infrastructure-institution non-linear interactions, feedback loops, and the emergent collapse or resilience
- Analyze cross-scale cascading failures, multi-level impact chain scenario mapping, and system-wide risk propagation patterns
- Identify critical thresholds and tipping points in social systems under hazard stress
- Integrate socio-cultural narratives, indigenous knowledge, and ethnographic co-modeling into agent-based computational frameworks
- Develop AI/ML approaches to detect phase transitions, resilience enablers/disruptors, and earlywarning signals
- Assess topological vulnerabilities, criticality, and robustness in infrastructure networks under dynamic post-disaster demand
- Examine the role of organizational culture, knowledge, and strategy in enhancing disaster risk governance through the application of CAS principles.

Topic 2) Qualitative research on the conceptualization of disaster resilience with CAS theory, as well as challenges, limitations, and future research directions.

This topic includes contributions that address the theoretical and conceptual aspects of applying the CAS framework in disaster resilience studies, as well as efforts to conceptualize CAS for its uptake in operationalized disaster risk management. It involves harnessing notions such as self-organized criticality, upward causation, reflexivity, hysteresis, attractors, self-organization, emergence, phase transitions, dependence on initial conditions, adaptive cycles, and the edge of chaos to understand and analyze perturbed sociotechnical systems under stressors from natural hazards and climate change. Furthermore, this session also addresses challenges, critiques, and limitations in integrating CAS and resilience studies. It explores whether applying CAS to disaster resilience is merely wishful thinking that leads to a new, confusing set of jargon on top of the already existing noise in the field, or a real opportunity — a lens and language that can connect different disciplines and unify a common understanding across sectors, scales, and levels. Examples of topics are:

- Emergent bottom-up resilience vs. top-down institutional disaster governance frameworks
- Reframing disaster adaptation, resilience, and vulnerability concepts through CAS theory
- Attractor basins in post-disaster socio-technical systems
- Role of trust, social capital, and risk perception in emergent collective behaviors in crises









- Pre-event predictive vs. retrospective explanatory capacity of CAS for natural hazards and urban disaster studies
- Conceptual frameworks for sociopolitical panarchic dynamics under natural hazards stress
- Infrastructure-governance-community-environment relations and adaptive co-evolution

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- Ethics, equity, power dynamics, and justice dimensions of decentralized self-organized adaptation in resilience processes
- Path dependencies, initial conditions, and historical constraints on systemic resilience trajectories and recovery pathways
- Operational challenges and critical perspectives in institutionalizing CAS approaches, barriers for research and policy translation.

TYPE OF CONTRIBUTIONS:

1. Call for Extended Abstracts (1.000 words) - see website for the template.

Including the possibility of submitting a Case Study - in this same template

2. Call for Pitches (500 words) - see website for the template

The pitches (5 min.) will serve as the starting point for round table discussions among stakeholders, policy makers, and researchers."

TRACK CHAIR AND CO-CHAIR

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