2026 ARISE Annual Symposium Speaker Abstracts

(Alphabetical order by first name)

Equity-Aware Load Prioritization and Planning Strategies to Improve Power System Resilience During HILF Events

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Power systems and other interdependent infrastructures are increasingly exposed to high impact low frequency (HILF) events, which can cause severe generation inadequacy and load curtailments that disproportionately affect vulnerable populations. To address this challenge, this work proposes an equity-aware optimal restoration and planning strategy applicable to any power network during an HILF event. First, a load prioritization framework is developed that incorporates customer criticality and social equity. The framework first allocates power to critical loads and non-critical loads are ranked using their economic value, social equity and load criticality. Secondly, an equity-oriented optimal switch placement framework is proposed as a long-term planning strategy to reduce disparities in post-event distribution system restoration across vulnerable communities.

Survway: A Next-Generation Conversational Survey Platform with AI Validation and Multilingual Support

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Traditional survey platforms rely on static forms that suffer from low engagement, rigid question flows, and limited multilingual support. We present Survway, a next-generation survey platform that transforms data collection into an interactive, chat-based experience. Researchers design surveys with conditional branching logic through a visual flow editor, while participants complete them through a conversational mobile interface powered by AI. The system features real-time answer validation using large language models, automatic translation for multilingual participants, and dynamic question routing based on previous responses. Survway also leverages motion and activity analysis on participants' devices to detect idle periods and intelligently suggest surveys during free times, maximizing response rates without disrupting daily routines. To drive participant retention, the platform incorporates a gamification layer with a tiered points economy, daily check-ins, and referral rewards — all configurable by platform

administrators. An integrated AI research assistant enables researchers to analyze collected response data through natural language queries with code execution and visualization capabilities.

Stochastic Computation Pipeline for Downscaling LODES to Household Level

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The Longitudinal Employer–Household Dynamics Origin–Destination Employment Statistics (LODES) dataset provides detailed information on commuting flows and worker characteristics at the Census Block level, but it does not identify workers at the household level. This limitation restricts its direct use in infrastructure resilience modeling, where household-level exposure and decision-making are critical. In this study, we develop a stochastic computational pipeline that downscales LODES employment data from Census Blocks to the household level by linking synthetic workers to pseudo-household units while preserving geographic and socioeconomic consistency.

The proposed framework integrates three components. First, block-level joint distributions of worker attributes (age, earnings, and industry sector) are reconstructed using Iterative Proportional Fitting (IPF) based on Residence Area Characteristics (RAC) marginals. Second, Origin–Destination (OD) commuting flows are expanded into synthetic worker records through probabilistic sampling constrained by OD marginals and the RAC-derived joint distributions. Third, workers are assigned to building-linked synthetic households generated by a Household Unit Allocation (HUA) model using a Hierarchical Stochastic Bipartite Matching (HSBM) procedure. The assignment prioritizes block-level geographic consistency while incorporating probabilistic alignment with household income and tenure patterns calibrated using Public Use Microdata Sample (PUMS) data.

We implement the pipeline across four counties representing diverse hazard and settlement contexts: Ford County, Kansas; Bastrop County, Texas; Suffolk County, Massachusetts; and Multnomah County, Oregon. Results demonstrate that the method preserves block-level employment structure, reproduces observed worker–household socioeconomic relationships, and generates a realistic synthetic population suitable for infrastructure and disaster resilience modeling.

Improving Post-Disaster Recovery: Understanding Households' Needs for Critical Resources and Services in the U.S. Central Great Plains

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Households need critical resources and services to sustain themselves after a disaster, which requires meeting urgent needs with limited resources This study examined household preferences concerning critical services to assess recovery needs after a natural disaster. We used primary data from a household-level survey conducted in the Central Great Plains of the U.S. employing a best-worst scaling experiment. Preliminary results indicate households prioritize safe and secure shelter, food, and drinking water as their top 3 priorities during recovery, with medical and restoration of power coming next. Information from the study can help guide disaster planning and response for communities.

Behavioral Economic Tasks as Decision-Support Tools for Hazard Preparedness and Infrastructure Planning

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Infrastructure planning for hazard preparedness often assumes that protective infrastructure will be used when it is available. However, protective action decisions are influenced by barriers, such effort, distance, and access constraints. While traditional survey methods provide important insights into perceptions and intended behavior, they often offer limited information about how decision-making is impacted by changes in barriers. Behavioral economic decision tasks provide a complementary approach by systematically varying barriers and observing how decisions shift under increasing constraints, allowing researchers to estimate behavioral response patterns relevant to planning contexts. This presentation will discuss the role of behavioral economic methods in resilience research and their potential as decision-support tools for hazard and infrastructure planning. Using data from Wave 1 household surveys as an example, we highlight how behavioral data can inform interdisciplinary resilience efforts, including integration with modeling approaches such as agent-based simulations. The presentation concludes by discussing broader applications of these methods across hazard contexts.

Community Engaged Heritage Mapping and GIS Risk Analysis at Highland Cemetery, Wichita, Kansas

Matthew Howland, Barb Myers, Timmerie Henke
Highland Cemetery, established in 1870 is Wichita’s oldest cemetery and holds the graves of many of the city’s founders and historical figures. Yet the cemetery, managed by the city of Wichita, also reflects the city’s legacy of de facto segregation. For

example, Richard Robinson, the only Black signer of the Wichita city charter, is buried in an unmarked grave at Highland and many of the cemetery's grave markers are degrading from natural causes, including flooding in parts of the cemetery. This paper describes an effort—in partnership with the local nonprofit group Friends of the Wichita Pioneers—at crowdsourcing spatial and 3D data about the condition of grave markers and their at-risk text across the entire cemetery. We use this data as the basis to map future flood disaster exposure to the cemetery's marked and unmarked occupants.

HABiT: A Hetero-functional Agent-Based Infrastructure Toolkit for Modeling Community Resilience

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We present HABiT, the Hetero-functional Agent-Based Infrastructure Toolkit, for simulating interdependent power, water, and transportation systems. HABiT models infrastructure as a network of functionalities, such as generating power, transporting water, or consuming vehicles. Each functionality is represented by an autonomous agent with defined behavior, location, and evolving states. The simulation operates over discrete time steps and includes stochastic elements such as random failures, uncertain repair durations, and probabilistic transport availability. We apply HABiT to a simplified model of three communities with different levels of infrastructure access and social vulnerability. The simulation captures both normal operations and disruptions, including recovery influenced by constrained resources, vehicle routing, and mobile repair agents.

HABiT uses a hetero-functional graph to represent interdependencies across functionalities. This structure allows components to be added or removed without altering the system configuration, supporting flexible scenario design. Results show that incorporating stochasticity reveals variations in failure cascades and recovery patterns that deterministic models may miss. HABiT enables rapid evaluation of infrastructure disruptions and supports decisions on resource allocation, recovery planning, and resilience analysis under uncertainty.

STRENGTHENING OUR COMMUNITIES THROUGH SMARTER, MORE RESILIENT NETWORKS: A GRAPH LEARNING PROSPECTIVE

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BACKGROUND AND PURPOSE: Critical infrastructure systems such as power, water, stormwater, and transportation form tightly interconnected networks vital for essential

services and public safety. Failures in one system often cascade, causing widespread disruptions and threatening lifelines such as hospitals and emergency services. Traditional single-system approaches overlook these interdependencies, dynamic operating conditions, and their broader community impacts. This research aims to develop a scalable framework that addresses dynamic network challenges by identifying critical functionalities, examining causal factors that drive failures, and guiding targeted resilience strategies such as asset hardening and targeted interventions. Our core questions are: Which functionalities and causal drivers most influence community-level resilience, and how can feasible interventions minimize cascading failures and inequities? METHOD: We propose an integrated framework combining Graph Neural Networks (GNNs) and Hetero-Functional Graphs (HFGs). GNNs learn network structure to accurately identify critical nodes and links based on operational data, while HFGs model the interdependencies among community infrastructure systems. To handle changing conditions, we employ dynamic tracking of network status using Wasserstein-based graph embeddings to detect network shifts over time. The technical approach includes GNN architectures for static topology and a dynamic GNN–LSTM model that fuses temporal data with graph structure, enabling real-time, causally informed interventions.

RESULTS/FINDINGS: The results highlight the advantages of learning-based methods, where feature-based metrics and dynamic embeddings capture the richness and complexity of evolving infrastructure networks. The framework achieves 97–99% accuracy in critical node identification and 98–99% for links, with roughly double the prediction speed of simulation methods. HFGs and the dynamic GNN–LSTM further quantify system-level and temporal impacts, providing nuanced insights into cascading failures, their causal drivers, and community consequences. CONCLUSION: This approach is computationally efficient and scalable, supports strategic system hardening and proactive decision-making in large-scale, dynamic infrastructure networks.

Resilience and Social Equity Indicators for Assessing Drinking Water Infrastructure

Rumana Sharmin, Elaina J. Sutley, Justin M. Hutchison, Ram Krishna Mazumderd, and Jason Bergtold

Water infrastructure resilience and equity are critical for ensuring reliable and fair access to water services; however, significant disparities persist across communities. This study develops a multi-dimensional framework to evaluate both resilience and equity in drinking water systems through two composite measures: the Composite Resilience Index (CRI) and the Water Equity Index (WEI). An initial pool of over 450

resilience and equity indicators was screened based on seven community capitals identified in the literature, resulting in 46 indicators. These were organized into two domains: system performance (e.g., reliability, continuity, redundancy, and water quality) and user experience (e.g., affordability, access, and perceived service quality). Based on data availability at the system level, a subset of eight indicators - four for resilience and four for equity - were selected for index construction, as well as primary data collected through community surveys. These indicators serve as inputs to the CRI and WEI. Both indices are constructed using multiple weighting and dimensionality reduction techniques, including Equal Weighting (EW), Entropy Weighting (EW-entropy), Rank Based Index (RBI), Relative Importance Index (RII), and Principal Component Analysis (PCA). Sensitivity analysis and scenario-based vignette analysis are ongoing and will be incorporated to evaluate the robustness of the indices and to examine how different policy priorities influence resilience-equity trade-offs. The planned vignettes include a (i) Baseline scenario reflecting existing system conditions; (ii) an Equity-Focused scenario prioritizing affordability and access improvements; (iii) a Resilience-Focused scenario emphasizing infrastructure reliability and redundancy; (iv) a Disaster Impact scenario simulating system stress under extreme events; and (v) a Balanced scenario integrating both equity and resilience objectives. The resulting indices will be visualized using heat maps and multi-dimensional plots to support interpretation. This integrated framework provides a systematic approach to jointly assess resilience and equity, offering practical insights for water utilities to identify disparities and inform more equitable and resilient infrastructure planning.

Play-Based AI Learning for Children

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Artificial intelligence is increasingly present in children's everyday lives, yet most AI education initiatives are designed for older students and rely on technical instruction that is not developmentally appropriate for young learners. To address this gap, we developed AI-Play, a play-based pedagogical framework that introduces foundational AI concepts to children through accessible, hands-on experiences. The framework organizes AI learning into four intuitive components: AI Food (data and examples), AI Body (inputs and outputs), AI Brain (patterns and learning), and an ethics and human-agency lens that emphasizes fairness, responsibility, and the human role in guiding AI systems. The framework was derived from a synthesis of major AI literacy standards and refined through expert feedback from early childhood educational technologists. After development, the framework was used to design a series of outreach activities that translate AI concepts into playful, developmentally appropriate

learning experiences for children and families. These activities were implemented across several community outreach programs, including Hour of Code workshops, a STEM Career Hunt event, and a Day of AI learning experience. Each event used hands-on activities, games, and guided exploration to help participants understand that AI systems are human-created, learn from examples, and can make mistakes. Initial feedback from participating children, parents, and educators indicated high engagement and improved conceptual understanding of AI.

Robust Building Damage Detection in Cross-Disaster Settings

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Rapid structural damage assessment from remote sensing imagery is essential for timely disaster response. Within human–machine systems (HMS) for disaster management, auto- mated damage detection provides decision-makers with action- able situational awareness. However, models trained on multi- disaster benchmarks often underperform in unseen geographic regions due to domain shift—a distributional mismatch between training and deployment data that undermines human trust in automated assessments. We explore a two-stage ensemble ap- proach using supervised domain adaptation (SDA) for building damage classification across four severity classes. The pipeline adapts the xView2 first-place method to the Ida-BD dataset using SDA and systematically investigates the effect of indi- vidual augmentation components on classification performance. Comprehensive ablation experiments on the unseen Ida-BD test split demonstrate that SDA is indispensable: removing it causes damage detection to fail entirely. Our pipeline achieves the most robust performance using SDA with unsharp-enhanced RGB input, attaining a Macro-F1 of 0.5552. These results underscore the critical role of domain adaptation in building trustworthy automated damage assessment modules for HMS-integrated disaster response

Roll Out: City Edition Breakout Session

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We want people to play the game we developed for the Family STEM Nights and that we've done with the REI students. This roll-playing game helps players see the importance and pitfalls of informed decision making, planning for disasters and other disruptions, etc. This is an environmental finance, prioritization, and community planning

and budgeting activity. The goal of this presentation would be to showcase the game and provide the group with the skills and resources to use the game in their own ways that support their outreach and learning objectives.

Cognitive Silicon: Synergizing Reasoning-Enhanced LLMs and PPA-Oriented Reinforcement Learning for Resilient and Secure Hardware Infrastructure

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The automation of hardware design via Large Language Models (LLMs) faces two critical bottlenecks: the "hallucination of functionality," where generated designs fail to meet strict semantic constraints, and "physical blindness," where syntactically correct code violates Power, Performance, and Area (PPA) requirements. This work presents a unified "Cognitive Silicon" framework that bridges these gaps through two novel methodologies. First, we introduce Function-Aligned Differentiated Revision (FADR), a reasoning-enhanced generation method that enforces a structured "Chain-of-Thought" planning phase, improving functional correctness (Pass@1) by 20% and eliminating logic bugs that often serve as security vulnerabilities. Second, we propose the PPA-RTL framework, which utilizes Reinforcement Learning (RL) with offline reward modeling to explicitly optimize post-synthesis metrics. This approach reduces power consumption by ~21% and area by ~29% without human intervention. By synergizing semantic reasoning with physical optimization, this framework addresses dual critical needs: it hardens the hardware supply chain against implementation flaws and enables the democratization of energy-efficient, custom sensor design for community resilience.

Manufactured housing vulnerability to multi climate hazards in the United States

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Manufactured housing (MH) faces unique sociodemographic and environmental challenges shaped by the physical characteristics of the homes, their siting in hazard-prone areas, and the socioeconomic vulnerabilities of residents. Representing about 6% of the national housing stock, MH provides vital affordable housing, particularly for low-income and rural populations (Fothergill and Peek 2004). Yet these homes remain disproportionately exposed to chronic stressors such as extreme heat and acute hazards, including tornadoes and floods. While these risks are not inevitable, addressing them requires systematic research to identify where and how vulnerabilities manifest, enabling more equitable and effective interventions.

This study conducted a nationwide analysis with the Federal Emergency Management Agency's disaster assistance data (2013–2022) to examine the relationship between MH damages, including roof, foundation, and personal property losses, and broader environmental, social, and policy contexts. For the analysis, we integrated multiple data sources at the census tract level, including FEMA's National Flood Hazard Layer (NFHL), which contains classification of flood zones (SFHA, Floodway, and Coastal), demographic (e.g., income, education, and age), land-use, and MH-related policy indicators to construct a multi-dimensional database of MH vulnerability.

By linking fine-resolution hazard data with social and infrastructural characteristics, this research enables comparative analyses of exposure patterns, advances the understanding of climate and housing inequality, and supports data-driven resilience planning across diverse geographic contexts.

Natural Disaster Impacts on Employment Across Industries in Local Communities

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From 1980 to 2024, 403 weather and disaster events have occurred, resulting in over $2.9 trillion in damage. It's important to understand the economic impact of these disasters for policy makers, especially in planning and providing government aid and economic support. We use monthly employment data of US counties from 2000-2025 to study dynamic impacts of natural disasters on employment. We find that natural disasters have significant positive impacts on employment in the construction sector in the short term and negative impacts on employment in health sectors in the longer term. No statistically significant impact was found for employment in other sectors such as agriculture, education and transportation. The results contribute to a better understanding of the labor market consequences of natural disasters and policy discussions related to resource allocation and recovery strategy.