KANSAS NSF EPSCOR

Adaptive and Resilient Infrastructures driven by Social Equity (ARISE)

Kansas NSF EPSCoR RII Track-1

RII Track-1: Adaptive and Resilient Infrastructures driven by Social Equity (ARISE)

OIA-2148878

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Project Dates: June 1, 2022 to May 31, 2027

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ARISE Vision Statement

ARISE will build research capacity in Kansas by creating a new social equity-driven paradigm for resilience analysis that, through a pipeline of community leaders and decision-makers, will transform how communities invest in, and manage, human and physical infrastructure.

ARISE Mission Statement

To determine how infrastructure resilience intersects with social equity and how human capacity, physical infrastructure, and policy levers can be designed to achieve socially equitable outcomes that collectively improve policy decisions and community resilience.

Introduction

The University of Kansas (KU) and its partners, Kansas State University (KSU), Wichita State University (WSU), Baker University, Donnelly College, and three community colleges (Butler, Johnson County (JCCC), Kansas City Kansas (KCKCC)) received an NSF EPSCoR Research Infrastructure Improvement (RII) Track-1 award (OIA-2148878) effective June 1, 2022. It is titled *Adaptive and Resilient Infrastructures driven by Social Equity (ARISE)*. This Strategic Plan describes the ARISE project and details its implementation.

Overall purpose

Current responses to extreme events rarely consider resilience preparation and relief efforts through an equity lens; recoveries for historically underrepresented groups lag far behind the average. This project's overall purpose is to address these disparities. Using Kansas-based testbeds that span population and climate gradients, along with case studies that encompass transportation, water, and energy sectors, ARISE will build an interested party-informed resilience-focused research community.
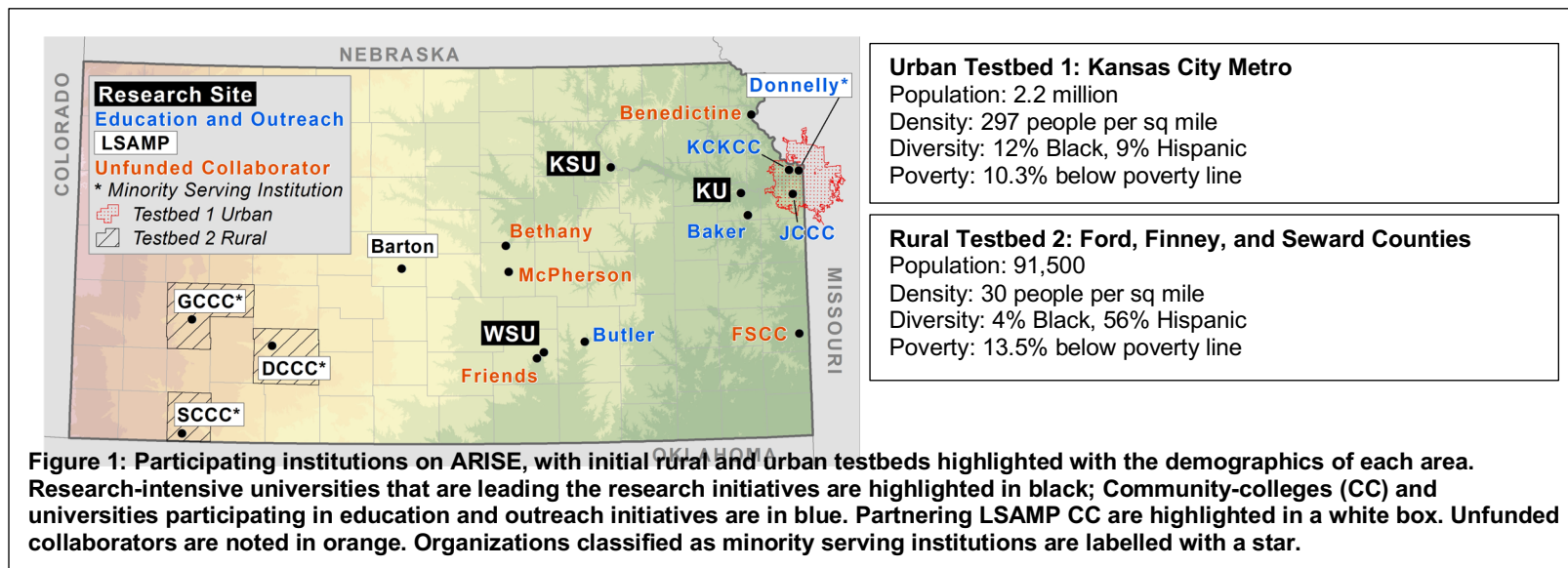
Alignment with State Science and Technology (S&T) Plan and benefits to Kansas' academic research and education infrastructure

The ARISE project builds research-driven improvements to physical and cyber infrastructure and human-capital development in Kansas for resilience and critical infrastructure systems. The topic area was approved by the Kansas Board of Regents (KBOR) through the Kansas EPSCoR state committee. The topic aligns with the Kansas Science and Technology (S&T) plan and was selected as having the best potential to improve future Research and Development (R&D) competitiveness and build research capacity in Kansas. ARISE aligns with three of four areas of growth described in the Kansas State Science and Technology (S&T) Plan: *Smart Infrastructure and Resilience, Precision Agriculture, and Digital Transformation and Automation*. This project will improve the state's S&T enterprise by significantly increasing research, education, and training capacity in data science, machine learning, complex network modeling, decision and risk management science, and social equity. Complementary to these priorities, the S&T plan also calls for enhanced infrastructure in *Rural Broadband and Connectivity, Data Literacy*, *Data Storage, and Open-data Access* to enable research. Specifically, the S&T Plan outlines that the state has invested more than $105 million to increase engineering graduates at the three accredited engineering schools (KU, KSU, WSU) over the last decade. With this investment ongoing, the S&T Plan aims to develop a workforce that can use open-access data and machine learning to harness the data revolution in Kansas. At the same time, it will connect engineering to social science and public administration research, creating convergent science opportunities.

Primary organizational partners and roles

The proposal is led by the University of Kansas (KU) with Kansas State University (KSU), Wichita State University (WSU), Baker University, Donnelly College (DC), three community colleges (Butler, Johnson County (JCCC), Kansas City Kansas (KCKCC)), and five participating colleges of an NSF-funded LSAMP program (Barton, Dodge City (DCCC), Garden City (GCCC), Seward County (SCCC), and DC). There are five additional unfunded collaborating institutions: Benedictine, Bethany, Fort Scott (FSCC), Friends, and McPherson. KU, KSU, and WSU are research-intensive institutions; DC, DCCC, GCCC, and SCCC are Hispanic Serving Institutions.

ARISE connects researchers at participating universities and colleges to outreach programs (KCKCC Saturday Academy, TRIO, LSAMP), community engagement and extension offices, and workforce development programs (WSU Environmental Finance Center, FSCC Environmental Technology Program) to build capacity and develop educational resources that span K-12 and higher education across Kansas, creating new STEM pipelines. A new Kansas Data Science Consortium (KDSC) creates a transferable training model that connects students trained in data science to local industry and organizations to develop data-driven solutions for the problems they face. The participating institutions are shown in Figure 1.

Figure 1: Participating institutions on ARISE, with initial rural and urban testbeds highlighted with the demographics of each area. Research-intensive universities that are leading the research initiatives are highlighted in black; Community-colleges (CC) and universities participating in education and outreach initiatives are in blue. Partnering LSAMP CC are highlighted in a white box. Unfunded collaborators are noted in orange. Organizations classified as minority serving institutions are labelled with a star.

Project management structure

The management structure of primary partners is provided in Figure 2. KBOR and Chief Research Officers (CRO) at the research-intensive universities provide matching funds for the project and oversight of the Kansas NSF EPSCoR program (KNE). The KBOR EPSCoR committee reviews projects in the context of the State S&T Plan and recommends matching funds to KBOR. The Committee consists of two CEOs, two emeritus professors, and government officials from the KS Department of Commerce and KBOR. The KNE Project Director consults with CRO each semester. Representatives appointed by CRO also help draft the State S&T plan, which is then reviewed by KBOR's EPSCoR review committee.

The KNE office is responsible for effective and efficient operation and supervision of NSF EPSCoR projects. The Project Director (PD)/PI (*Sturm*) administrates all KNE operations and external relations (including those with institutional leaders and KBOR constituencies); provides vision and leadership; and oversees report preparation, proposal writing, and strategic planning for current and future initiatives (with input from CRO). The office staff consists of a Program Administrator (PA), a Financial Manager, and an Education and Outreach Director (EOD). The PA oversees project management, including data collection for reports and interacting with other jurisdiction PAs to determine best practices. The Financial Manager provides fiscal oversight for the project and budget preparation. The EOD oversees all education initiatives and assists with external communication of research and education initiatives to the broader public. In Year 3, an Associate Project Director will be identified to train under PD *Sturm*. The Assoc PD will attend project team meetings and annual NSF visits and will assist with the management of ARISE.

The **Project Management Team** consists of two lead Co-Investigators *Natarajan* (KSU) and *Sutley* (KU); representative theme leaders for the research projects, *Aravinthan* (WSU), *Bergtold* (KSU), *Krause* (KU); the lead investigators for major education projects, *Pleskac* (KU), *Watson-Thompson* (KU), *Bergtold* (KSU); and the KNE PD, PA, and EOD (KNE). The project management team includes eight faculty (four female, four male, of whom one is a minority) and two staff (one female; one male). Staff project coordinators will also be invited to management team meetings, which will occur monthly. In addition, team leaders, researchers, and students will hold biweekly research meetings for each of the research or outreach areas, with larger inter-group meetings convened every two months.
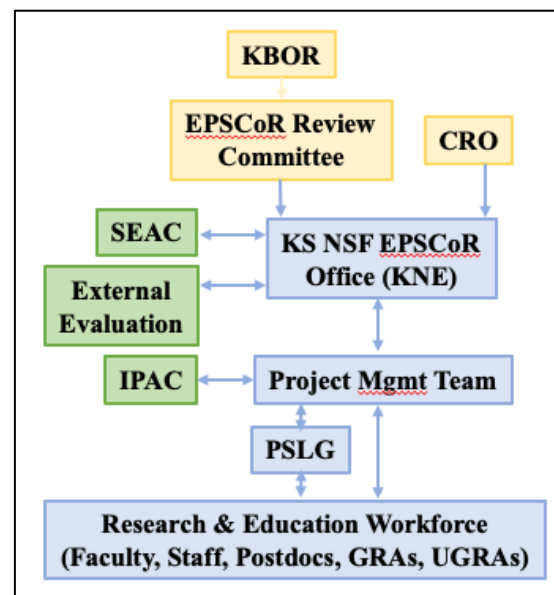
Figure 2. RII Track-1 Kansas NSF EPSCoR management structure

Table 1. ARISE Project Management Team

Investigator	Title	Univ.	Project Role
Belinda Sturm (she)	Director / Prof	KNE	Principal Investigator, Project Director
Bala Natarajan (he)	Prof	KSU	Research Project Co-Lead, Theme 2 Co-Lead
Elaina Sutley (she)	Assoc Dean Diversity / Assoc Prof	KU	Research Project Co-Lead, Theme 4 Co-Lead
Jason Bergtold (he)	Prof	KSU	Theme 1 Co-Lead, REU Lead
Rachel Krause (she)	Prof	KU	Theme 2 Co-Lead
Visvakumar Aravinthan (he)	Assoc Prof	WSU	Theme 3 Co-Lead
Tim Pleskac (he)	Chair / Prof	KU	Kansas Data Science Consortium Lead
Jomella Watson-Thompson (she)	Prof	KU	Community Engaged Research Lead
Doug Byers (he)	Asst Director	KNE	Project Administrator
Claudia Bode (she)	Education and Outreach Director	KNE	EOD

The Post-doc and Student Leadership Group (PSLG) will be formed from three representatives from each campus, with postdocs, graduate, and undergraduate students represented. This group provides direct feedback to project management and will enable a sense of community across the project. Student leaders will organize poster sessions at our annual in-person meetings and virtual meetings, and the PSLG will be asked to contribute ideas for training and professional development that KNE will then organize.

Advisory Councils: Two advisory councils guide this project, in addition to the external evaluations. The **Science and Education Advisory Committee (SEAC)** provides objective scientific and education input and guidance. This committee will be informed by a yearly external evaluation and will provide input on a) progress toward goals and objectives, b) necessary adjustments as the project progresses, and c) feedback on reverse site visits. The SEAC meets annually during the statewide conference. Confirmed members (three women) include: Jamie Kruse, Distinguished Professor (East Carolina U) and Co-Director of the Center for Risk-based Community Resilience Planning (Colorado State U); Ann-Margaret Esnard (Georgia State U, an MSI), Associate Dean for Research and Distinguished Professor in Public Management and Policy; Yilu Liu, (U Tennessee), UT-ORNL Governor's Chair Professor, member of the National Academy of Engineering, and Fellow of IEEE; Mahantesh Halappanavar (Pacific Northwest National Laboratory), Group Leader of the Data Sciences and Machine Learning Intelligence Group. The **Interested Party Advisory Council (IPAC)** includes representatives from the testbed communities involved in the research initiatives, including utility service providers, industry consultants, city/state administrators, planner and emergency management staff, and representatives from social organizations. **Community Engagement Studios** will convene a panel of community experts, who will provide feedback and inform study design, including how to engage a population and the appropriate methodologies or research interests from a community perspective. Community Engagement Studios will increase participation and support funding applications while prioritizing community interested party involvement. To promote equitable practice, community panelists will be provided stipends. This strategy has been effectively supported at several institutions, including at Vanderbilt and the University of Minnesota.

Table 2. Science and Education Advisory Committee (SEAC)

Investigator	Title	Univ.
Jamie Kruse	Distinguished Professor / Co-Director Center for Risk-based Community Resilience Planning	East Carolina Univ
Ann-Margaret Esnard	Assoc Dean Research / Distinguished Prof	Georgia State Univ
Yilu Liu	UT-ORNL Governor's Chair Prof	Univ Tennessee
Mahantesh Halappanavar	Group Leader Data Science and Machine Learning Intelligence Group	Pacific Northwest Natl Lab

ARISE Project Implementation

Overview

ARISE seeks to determine how infrastructure resilience intersects with social equity and how human capacity, physical infrastructure, and policy levers can be designed to achieve socially equitable outcomes that collectively improve policy decisions and community resilience. It will build academic research capacity in Kansas for technology-enabled "smart and resilient" infrastructure research to transform rural and vulnerable communities that are typically under-represented in smart cities research. Based on the overall hypothesis that resilience efforts that center on principles of equity will lead to model outcomes that meet the needs of underserved community members and result in communities recovering faster and more equitably after disasters, as compared to outcomes obtained via a model-driven decision structure focused purely on infrastructure system efficiency.

The project is structured around four research themes and a cadre of integrated education, workforce development, and diversity objectives. Each ARISE research theme is co-led by both a social scientist and at least one engineer (see Table 3). *Theme 1* builds the necessary foundation for understanding and developing community-driven equity measurements, embeds our team within our testbed communities, and creates a general modeling framework that integrates physical infrastructure systems and social factors with stochastic interdependencies. *Theme 2* builds the necessary resilience evaluation framework and hazard scenarios relevant to Kansas. *Theme 3* tests our overall hypothesis through four case studies considering real threats in Kansas communities, spanning transportation, energy, water, and wastewater systems. *Theme 4* uses principles of choice architecture and nudges from behavioral economics to design decision-support tools to improve the decisions of community interested parties and institutional decision-makers. We will develop and test a decision-support tool incorporating the novel paradigm of holistic, social equity-driven resilience analysis for a general class of cyber-physical-social systems.

Each ARISE research theme is co-led by both a social scientist and at least one engineer (see Table 3).

Table 3. ARISE Research Theme Leaders with key expertise highlighted in brackets

Research Theme	Theme Co-Lead (Social Scientist)	Theme Co-Lead (Engineer)
1	**Jason Bergtold**, KSU (Economics, nonmarket valuation)	**George Amariucai**, KSU (Stochastic modeling)
2	**Rachel Krause**, KU (Policy adoption)	**Bala Natarajan**, KSU (Stochastic modeling, network science)
3	**Xiaoheng Wang**, WSU (Public finance, capital asset management)	**Visvakumar Aravinthan**, WSU, **Justin Hutchison**, KU, **HM Abdul Aziz**, KSU (Power system planning, water treatment, transportation, respectively)
4	**Derek Reed**, KU (Behavioral economics)	**Elaina Sutley**, KU (Social vulnerability measures)

Also included in this strategic plan are essential project elements built around achieving success and sustaining the ARISE research mission. These include *Partnerships and Collaborations*, *Communication and Dissemination*, *Sustainability*, and *Management, Evaluation, and Assessment*.

A detailed description of the ARISE project implementation follows. Each section includes a table of goals, objectives, activities, and a five-year timeline of milestones and outputs.

Theme 1 – Socially Equitable Interdependent Infrastructure for Resilience Analysis

The primary goal of Theme 1 is to build a tool, in the form of a computer model, to enable the optimization of utilities' strategies to enhance resilience against natural and man-made disasters and extreme events. Furthermore, the tool will uniquely consider interrelated infrastructures and the impacts on lives within and across communities, to provide efficient and socially-equitable responses to man-made and natural disasters.

Theme 1 team members are summarized in Table 4. Contributing members from other project areas are also listed in Table 4.
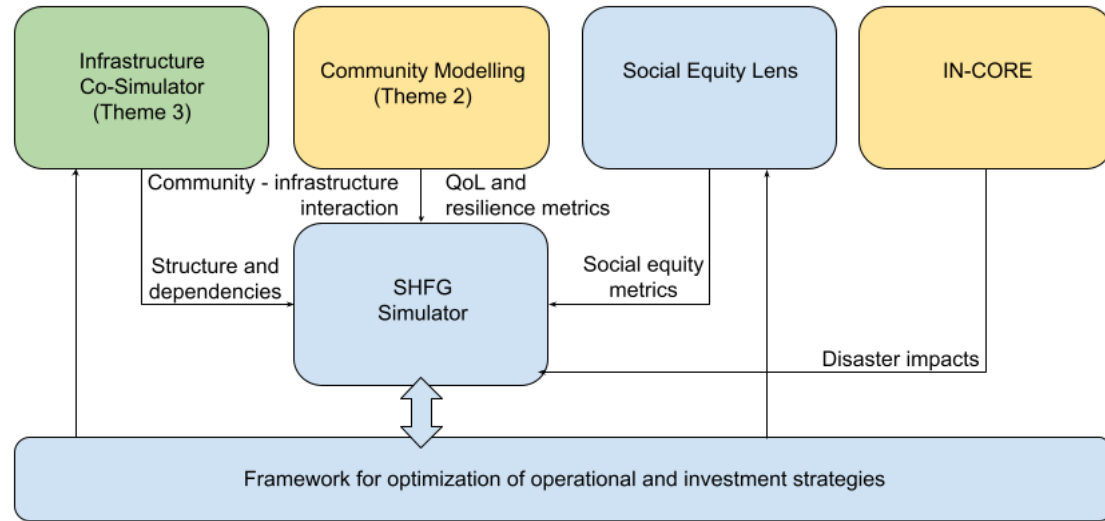
Table 4. Theme 1 team members

Investigator	Title	Univ.	Expertise
Jason Bergtold (he), Theme Co-lead	Prof	KSU	Economics, nonmarket valuation
George Amariucai (he), Theme Co-lead	Assoc Prof	KSU	Stochastic modeling
Honghseng He (he)	Asst Prof	WSU	Machine learning, automation
Joel Mendez (he)	Asst Prof	KU	Social justice, transportation planning
Bala Natarajan (he)	Prof	KSU	Stochastic modeling and analysis, network science
Derek Reed (he)	Prof	KU	Behavioral economics, decision-making
Elaina Sutley (she)	Assoc Dean Diversity / Assoc Prof	KU	Social vulnerability measures, risk-based decision-making
Xiaoheng Wang (she)	Asst Prof	WSU	Public finance, capital asset management
Contributing investigators from other project areas			
Rachel Krause (she)	Prof	KU	Policy adoption, local government
Emily Rountree (she)	Education Program Coordinator	KU	Community-engaged research

The search for such optimal strategies usually requires the fast and efficient evaluation of large numbers of potential candidates. When multiple interconnected utilities are modeled via complex co-simulation platforms, the computational requirements prevent the evaluation of many strategies in an agile fashion, making optimization a slow and cumbersome process. Theme 1 proposes an agile solution based on a stochastic hetero-functional graph (SHFG) that can capture the sophisticated inter-dependencies of large-scale models in a lightweight, graph-based simulator (Figure 3), meaning that the heavy co-simulation environment will only be needed for learning the SHFG model – a cost that is easily amortized over the model's service life. Nevertheless, a realistic and accurate such

co-simulation environment – such as that provided by the research thrusts underlining Theme 3 – is indeed vital for training an accurate SHFG model.

As the optimization of response and investment strategies first requires the establishment of a hierarchy of values, the SHFG model will be enhanced with the addition of (1) a quality-of-life (QoL) and resilience translator, mapping the supply and demand of resources to community-specific perceived QoL and resilience metrics, and (2) a social-equity lens for evaluating cross-community QoL restoration. The QoL and resilience translator, taking into account both the utilities' classic institutional resilience metrics and community-specific QoL aspects, will be provided by Theme 2. However, for a complete definition of the proposed hierarchy of values and social equity, Theme 1 is also concerned with the definition and measuring of social equity, in the context of the community capitals framework. To achieve this objective, Theme 1 proposes the design and execution of multiple waves of surveys across the state of Kansas and in two testbeds (rural and urban). Surveys will collect primary data related to the six community capitals, which will be supplemented with secondary sociodemographic data. We will develop measures of social equity spanning the six community capitals, as well as provide data and conditions for a social and economic baseline to be incorporated in the modeling SHFG framework.

Figure 3. SHFG agile simulation platform as a tool for optimization, and its dependence on the project's other themes and research topics

Finally, to allow for investment strategy optimization in the sense of average benefits to the communities served, where the randomness is over the uncertainty in the impacts of natural and man-made disasters and extreme events, Theme 1 also aims at integrating the SHFG tool with IN-CORE (Interconnected Networked Community Resilience Modeling Environment), a NIST-funded open-source research tool that can provide realistic estimates of the impacts of disasters on the built environment.

1. Theme 1: (T1) – Socially Equitable Interdependent Infrastructure for Resilience Analysis

Goal 1. Design, build and validate a highly versatile modeling framework to capture inter-dependencies between multiple infrastructures, exchange of, and access to, interrelated infrastructure services, and the impacts on lives within and across the communities they serve, to enable efficient and socially-equitable responses to natural and man-made disasters and extreme events.

- Objective 1.1 Measuring Social Equity - Collect and use primary data supplemented with sociodemographic secondary data to develop measures spanning six dimensions of social equity and to establish the social and economic baseline to be incorporated into the modeling framework for equity-driven resilience analysis.
- Objective 1.2 SHFGT Framework - Develop a unique SHFGT modeling framework to capture interdependencies between electricity, water, and transportation infrastructures, exchange of and access to infrastructure services, and impact on lives across communities.
- Objective 1.3 SHFGT Model Specification and Validation - Evaluate the SHFGT modeling framework through multiple test cases, against results obtained from a comprehensive infrastructure Co-Simulator, coupled with human and community impact assessments based on T1-1 surveys and Interested Party Advisory Council (IPAC) feedback.

Objective 1.1 Measuring Social Equity	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 1.1a: Identify/develop indicators and metrics for six dimensions of social equity	i. Literature review on social equity metrics. ii. Meet with interested parties in conjunction with Activity 2.1.1.a to collect social equity metric data and planning.	i. Hold focus groups with testbed community interested parties to refine list of social equity metrics and indicators. ii. Train Community Engagement Advocates (CEAs) and IPAC to assist with facilitating or co-hosting focus group sessions.	i. Hold focus groups with testbed community interested parties to refine list of social equity metrics and indicators. ii. Assess social equity metric design using Wave1 & 2 survey and secondary data. iii. Engage CEAs and IPAC to assist with facilitating or co-hosting focus group sessions.			**Sutley**, Bergtold (and team members: Mendez, Reed, Wang, Krause, Rountree, 2 Postdocs, 5 GRAs)

Activity	Col1	Col2	Col3	Col4	Col5	Lead
Activity 1.1b: Executing Surveys in Testbed Areas	i. Design of Wave 1 surveys based on Theme 1-4 needs and priorities. ii. Contact lists for testbed communities available. Sample survey designed. iii. IRB approval finalized.	i. Administer Wave 1 surveys. ii. Output: Produce Wave 1 synopsis. iii. Design Wave 2 Surveys based on Wave 1 findings and gaps and data needs from Themes 1 - 4.	i. Obtain IRB approval for Wave 2 surveys. ii. Administer Wave 2 surveys. iii. Output: Produce Wave 2 synopsis. iv. Design Wave 3 Survey based on Wave 2 findings, gap and other research needs.	i. Obtain IRB approval for Wave 3 surveys. ii. Administer Wave 3 surveys. iii. Output: i Produce Wave 3 synopsis.	i. Analyze survey data. ii. Output: Provide community- friendly report and presentation to testbed communities of relevant findings.	**Sutley**, Bergtold (and team members: Mendez, Reed, Wang, 2 Postdocs, 5 GRAs)
Activity 1.1c: Executing Surveys Outside of Testbed Areas	i. Design Wave 1 surveys. ii. Obtain list for designing sample. iii. Obtain IRB approval for Wave 1 survey.	i. Administer Wave 1 survey. ii. Output: Produce Wave 1 synopsis. iii. Design Wave 2 survey based on Wave 1 findings and gap and data needs from Themes 1 - 4.	i. Obtain IRB approval for Wave 2 survey. ii. Administer Wave 2 survey. iii. Output: Produce Wave 2 synopsis.	Design Wave 3 survey based on Wave 1 and 2 findings and gaps, and other data needs from Themes 1 - 4.	i. Obtain IRB approval for Wave 3 survey. ii. Administer Wave 3 survey. iii. Outputs: Produce Wave 3 synopsis. iv. Peer-reviewed publication about social equity and community resilience using a CCF framework.	**Bergtold**, Sutley (and team members: Mendez, Reed, Wang, 2 Postdocs, 5 GRAs)
Activity 1.1d: Obtain and organize secondary data to supplement survey data	i. Compile secondary data needs and begin data collection	i. Collect testbed community secondary data. ii. Integrate secondary data with survey data.	i. Collect testbed community secondary data. ii. Integrate secondary data with survey data.	i. Collect testbed community secondary data. ii. Integrate secondary data with survey data.		**Sutley**, Bergtold (and team members: Mendez, Reed, Wang, 2 Postdocs, 5 GRAs)
Activity 1.1e: Conduct assessments of diversity, segregation, and equity along the six community capital dimensions.			i. Work with Themes 2 and 3 to develop a framework for regression models of social vulnerability and equity using the CCF and regression and statistical models. ii. Output: Equity metrics to Themes 2 & 4.	i. Work with Themes 2 and 3 to develop community capital regression and statistical models. ii. Output: Produce social vulnerability hotspot maps.	i. Validate social vulnerability hotspot maps through IPAC feedback. ii. Present findings on diversity, segregation, and equity across the six community capitals for testbeds. iii Output: Peer-reviewed publication on social equity metrics and hotspot maps.	**Bergtold**, Sutley

Objective 1.2 SHFGT Framework	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 1.2a: Critical infrastructure data collection for synthetic system	Standard open source water, energy and transportation network models ready and tested.					**Natarajan**, Amariucai,, 1 Post-Doc, 2 GRAs
Activity 1.2b: Critical infrastructure data collection specific to testbed communities	NDAs and Data sharing agreements established with at least 1 testbed community.					**Natarajan**, Amariucai, Bergtold, 1 Post-Doc, 2 GRAs
Activity 1.2c: Multi-layer network and SHFGT model development for critical infrastructures	Multilayer network model for synthetic system.	System knowledge graph and process relation graphs for synthetic system and at least 1 testbed community ready.	System knowledge graph and process relation graphs for synthetic system and at least 1 testbed community ready.	i. Design of water-energy; transportation-energy and water-transportation sub graph dependency models completed for use in Theme 3 activities. ii. Output: peer-reviewed article		**Natarajan**, Amariucai, 1 Post-Doc, 2 GRAs
Activity 1.2d: Develop approaches to incorporate socio-economic factors and QoL within the SHFGT framework		i. Quantifed QoL based on synthetic data - integrated SHFGT model for synthetic system ready. ii. Output: SHFGT model (To 1.1.3b(Y3)).	i. Quantifed QoL based on survey results and community data (i.e.,) mapping QoL to community resilience metrics based on community capitals. ii. Integrated SHFGT model ready for at least 1 testbed. iii. Output: SHFGT model. (To 1.1.3b(Y4)).	i. QoL integrated SHFGT model specific to Thrust 3 activities. ii. Output: peer-reviewed article	i. Integrated SHFGT model for all testbed communities ready. ii. Output: SHFG modelling workshop — dissemination across interested parties.	**Natarajan**, Amariucai, Bergtold, 1 Post-Doc, 2 GRAs

Objective 1.3 SHFGT Model Specification and Validation	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 1.3a: Co-simulator design and development	i. Cosimulator component software identified and design architecture finalized; ii. Required hardware purchased.	Cosimulator implemented for synthetic system.	Cosimulator implemented for at least 1 testbed system.	i. Cosimulator implemented for additional testbed communities; ii. Output: Co-simulator with high-resolution models.	i. Output: Publications and establish access to co simulator across Kansas institutions. ii. Output: Access to co simulator across Kansas institutions.	**He, Amariucai** (and Infrastructure Expert Representatives Aravinthan, Aziz, Hutchison, Pahwa, Peltier, Sharda, Sturm, 1 Post-Doc, 4 GRAs)
Activity 1.3b: SHFGT validation	Scenarios for testing and validation defined.	Partial SHFGT model - evaluation/validation using energy infrastructure simulator.	Partial SHFGT model evaluation with only water and only transportation infrastructure simulators.	SHFGT validation with water-energy-transportation co simulators.	Output: peer-reviewed article on learning SHFG models from realistic co-simulators.	**Amariucai**, Natarajan
Activity 1.3c Integration with IN-CORE		Complete IN-CORE Training.	Establish IN-CORE, HFGT and QoL integration needs based on community inputs.	QoL Integrated HFGT models within IN-CORE.	I. Testing of QoL integrated HFGT models within IN-CORE; ii. Output: SHFGT Model integrated with IN-CORE.	**He**, Amariucai, 1 GRA

Research Outcomes and Capacity building: Theme 1 will expose inequities and enhance capabilities of current infrastructure system designs, administration policies, modeling, and simulation tools. The research will compile a longitudinal geodatabase that will feed into Themes 2-4 and substantial future convergence research opportunities. The highly flexible SHFGT framework and ARISE Co-Simulator platform will be available to researchers and the general public as a simulation-as-a-service asset.

Theme 2 – Scalable Holistic Resilience Evaluation

Theme 2 aims to identify opportunities to enhance both equity and resilience through interventions (e.g., infrastructure system enhancements, professional capacity improvements, and public policies). To do this, we will holistically and probabilistically evaluate the influence that existing infrastructure assets, institutional networks, and public policies have on the pre-disaster context and post-disaster experiences of diverse communities across the state of Kansas.

Theme 2 team members are summarized in Table 5. Contributing members from other project areas are also listed in Table 5.

Table 5. Theme 2 team members

Investigator	Title	Univ.	Expertise
Rachel Krause (she), Theme Co-lead	Prof	KU	Policy adoption, local government
Bala Natarajan (he), Theme Co-lead	Prof	KSU	Stochastic modeling and analysis, network science
Elaina Sutley (she)	Assoc Dean Diversity / Assoc Prof	KU	Social vulnerability measures, risk-based decision-making
Xiaoheng Wang (she)	Asst Prof	WSU	Public finance, capital asset management
Jude Kastens (he)	Assoc Research Prof	KU	GIS, remote sensing, flood models
Contributing investigators from other project areas			
George Amariucai (he)	Assoc Prof	KSU	Stochastic modeling
Visvakumar Aravinthan (he)	Assoc Prof	WSU	Power system planning, renewable integration, and demand management
HM Abdul Aziz (he)	Asst Prof	KSU	Transportation networks
Jason Bergtold (he)	Prof	KSU	Economics, nonmarket valuation
Justin Hutchison (he)	Asst Prof	KU	Drinking water, sustainability analyses
Derek Reed (he)	Prof	KU	Behavioral economics, decision-making
Emily Rountree (she)	Education Program Coordinator	KU	Community-engaged research

The first objective of Theme 2 is to develop metrics for evaluating community resilience holistically and equitably. Community resilience will be measured using six community capitals, which will be referred to as the community capitals framework (CCF). These will be combined with Quality of life (QoL) and quality of service (QoS) resilience metrics in Year 3. Theme 2 members will complete literature reviews and conduct interviews, focus groups, and surveys of community partners to operationalize and measure resiliency.

A second objective is to identify the decisions that governments and other public-facing organizations make that shape equity and resiliency in Kansas communities and link those decisions to the community capital framework. Understanding the process of how these decisions are made, the factors that influence them, and the networks that exist around them are component parts of this objective. This will be explored in Years 1 and 2 via a series of interviews with decision makers in government, utility, and relevant

community organizations. In Years 2 and 3, surveys will be administered to decision makers across the state and in the two testbed communities, respectively. Statistical analysis of collected data and geographically representative statewide network maps of organizational connections will be completed in Year 3.

The third objective involves developing probabilistic measures, simulations, and analysis to illustrate the likely locations of hazards across the state of Kansas and demonstrate how their impacts can be inequitable. As part of this, the alignment of equitable community well-being and the resilience of the built environment will be evaluated. Key milestones include the completion of probabilistic characterizations of weather events in Year 3, and QoS and quality of life QoL impacts fully tested and used to develop resilience heat maps in Years 3 and 4, respectively.

The final objective in Theme 2 is to develop a scalable and generalizable Graph neural network (GNN)-based framework to determine assets and resources critical to system and community resilience. This analysis will provide feedback to decision makers on what assets and functionalities have to be hardened to enhance resilience. By Year 5, we will leverage the probabilistic analysis along with the GNN framework in both test beds to develop recommendations for resilience enhancements strategies that can mitigate inequities.

To conduct this work, the members of Theme 2 will utilize the Community Check Box, a tool developed by the KU Center for Community Health and Development designed to capture and communicate data. The Community Check Box will be used in conjunction with the larger EPSCoR team for when and how to contact relevant partners and potential survey participants. This is particularly important in the testbeds where contacts should be coordinated.

Products developed as part of Theme 2 will be provided to other themes in Years 3 and 4 of the project. Specifically, resiliency metrics will be provided to Theme 1 and resiliency analysis will be provided to Theme 3 in Year 3. Testbed specific data and network map of the linkages between infrastructures and institutional actors will be provided to Theme 3 in Year 4. Members of Theme 2 will work with Theme 4 to help determine characteristics of decision-making tools that are likely to be adopted.

2. Theme 2: (T2) – Scalable Holistic Resilience Evaluation

Goal 2. Quantify and evaluate the influence that institutional networks, infrastructure assets, and public policies have on pre-disaster context and post-disaster experiences of diverse communities across the State of Kansas using a holistic, probabilistic, and scalable resilience evaluation spanning the community capitals.

- Objective 2.1 Holistic Resilience Metric Development Spanning Community Capitals - develop metrics for evaluating community resilience holistically and equitably.
- Objective 2.2 Institutional Decision-Making - develop linkages between institutional decisions and asset importance to the community capitals for holistic resilience measurement, and to evaluate the extent to which equitable community well-being and the resilience of the built environment do or do not align.
- Objective 2.3 Probabilistic Resilience Characterization - Develop probabilistic measures and increased associated analyses to (1) illustrate how hazard impacts can be inequitable and (2) identify where resilience can mitigate inequities.
- Objective 2.4 Scalable Resilience Computation with Uncertainties - Develop a novel, generalizable ML framework to efficiently evaluate (deterministic or probabilistic) resilience metrics that can be used to guide decision-makers.

Objective 2.1 Resilience Metric Development	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 2.1a: Identify/develop resilience metrics covering six community capitals	Completed and validated the portion of the survey instrument described in Theme 1 that is relevant to the development of resiliency metrics	i. Completed focus groups with testbed community interested parties to refine list of resilience metrics. ii. Output: Realistic metrics for QoL, and dependence on available resources. (To 1.2d(Y3)).	i. Completed focus groups with testbed community interested parties, including CEAs, to refine list of community resilience metrics and indicators. ii. Assess community resilience metric design using Wave 2 survey and secondary data. iii. Output: QoL resilience metrics, and dependence on available resources (To 1.2d(Y4)).			**Sutley** (and team members: Krause, Natarajan, Hutchison, Aziz, Kastens, Bergtold, Amariucai, 2 GRAs, post-doc; Emily Rountree (CSL); Community Partnership Coordinator)

Objective 2.2 Institutional Decision-Making	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 2.2a: Design survey instruments	i. Sampling frame determined. ii. Contact information collected. iii. Interviews completed with	Needed input – social capitals metrics from 2.1; i. Output: Complete survey instrument for state of KS municipal effort. ii.	Output: Complete survey instrument for testbed effort.			**Krause**, Wang, Postdoc (and team members: Envr Finance Center, Reed, Bergtold, all team 3 leaders, Roundtree)

	relevant municipal interested parties.	Interviews completed with relevant testbed interested parties.				
Activity 2.2b: Administer surveys		Municipal survey administered.	Testbed survey administered.			**Krause**, Roundtree Postdoc
Activity 2.2c: Compile and analyze data			Output: Completed and cleaned survey dataset merged with financial and other archival information for all cities in KS.	Outputs: i. Set of statewide network maps. ii. Set of testbed network maps. iii. Dataset providing quantitative indicators of actor importance shaping resiliency decision- making in KS and testbeds.		**Krause**, Wang, Postdoc (and team members: Kastens, GRA)

Objective 2.3 Probabilistic Resilience Characterization	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 2.3a Building weather event models	Weather data collection related to test systems completed.	i. Weather event scenarios for the test systems defined, ii. Output: Presentation of future extreme weather event data to Team 3.	Probabilistic characterization of weather events completed.	Expand weather event models to other parts of Kansas.	Output: Report on weather event scenarios completed.	**Kastens**, GRA
Activity 2.3b Holistic characterization of impact of weather events	Completed review of weather event models in IN-CORE.	Co-simulation to characterize QoS impacts for synthetic test system.	QoS and QoL impacts on synthetic test system quantified.	Output: Resilience heatmap for one test system completed.		**Natarajan**, Sutley Amariucai

Objective 2.4 Scalable Resilience Computation	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 2.4a Develop GNN-based scalable and generalizable approach to identify critical assets to harden or invest in.	GNN-based approach to critical node identification developed and tested on a general graph.	GNN-based approach and uncertainty quantification complete for the synthetic test system.	GNN-based approach tested for at least 1 testbed community using both QoS and QoL aspects.	Uncertainty quantification completed and node set identification for at least 1 testbed community.	GNN-based approach applied to both testbeds.	**Natarajan**

Research Outcomes and Capacity building: (1) A publicly-available online "dashboard" delineating the six community capitals and providing their measurements for select Kansas communities; (2) A spatially representative network map identifying communications and resource flows, relevant to disaster preparation and response, between public institutions in Kansas; (3) A probabilistic model able to estimate where, in the lifespan of a disaster, gaps between the state of asset function and community well-being are most likely to manifest and enable measurement of the presence, size, and persistence of any lags between their recoveries; and (4) A scalable GNN-based inductive learning framework for resilience evaluation. Collectively, the innovations in Theme 2 will serve as the foundation of future funding pursuits in areas related to equity-driven resilience, network science, and digital transformation.

Theme 3– Infrastructure Enhancement and Decision Levers: Case Studies

The primary focus of Theme 3 is to identify the interdependency between transportation, drinking water, storm water and electricity infrastructure and build a co-simulation platform. This co-simulation platform will help realize the real-world relationships between hazards and infrastructure systems in short- and long-term decision-making scenarios. This can be used by the rest of the themes to identify interventions to enhance the resilience. In addition, each infrastructure group will focus on using the knowledge gained from other themes to develop long-term and or short-term decisions to improve system resiliency.

Theme 3 team members are summarized in Table 6. Contributing members from other project areas are also listed in Table 6.
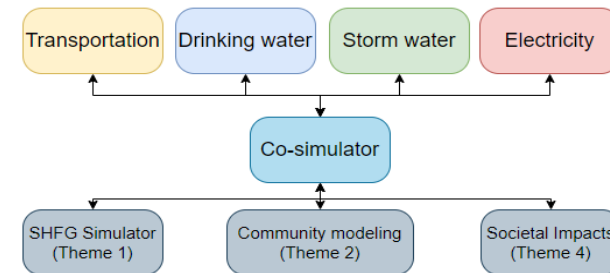
Figure 3. Holistic framework to improve infrastructure resilience

Table 6. Theme 3 team members

Investigator	Title	Univ.	Expertise
Xiaoheng Wang (she), Theme Co-lead	Asst Prof	WSU	Public finance, capital asset management
Visvakumar Aravinthan (he), Theme Co-lead	Assoc Prof	WSU	Power system planning, renewable integration, and demand management
HM Abdul Aziz (he)	Asst Prof	KSU	Transportation networks
Justin Hutchison (he)	Asst Prof	KU	Drinking water, sustainability analyses
Jude Kastens (he)	Assoc Research Prof	KU	GIS, remote sensing, flood models
Joel Mendez (he)	Asst Prof	KU	Social justice, transportation planning
Anil Pahwa (he)	Univ Dist Prof	KSU	Power and distribution systems
Edward Peltier (he)	Assoc Chair / Prof	KU	Water quality modeling, statistics
Vaishali Sharda (she)	Asst Prof	KSU	Hydrologic modeling, risk assessment
Belinda Sturm (she)	Prof	KU	Project Director, wastewater engineering
Xiaoheng Wang (she)	Asst Prof	WSU	Public finance, capital asset management
Contributing investigators from other project areas			
Bala Natarajan (he)	Prof	KSU	Stochastic modeling and analysis, network science

To develop credible models, data from infrastructure partners will be collected for both urban and rural communities. The interactions for the holistic framework development are shown in Figure 3.

Four distinct Case Studies are proposed as described below:

Case Study 1: Transportation Management and Recovery Planning – This Case Study seeks to develop post-disaster route prioritization methods for restoration and recovery based on stochastic optimization techniques accounting for the trade-off between efficiency and equity. The objective of Case Study 1 is to develop a novel mathematical optimization framework to investigate the trade-off between efficiency and equity-based post-disaster route prioritization. The framework will be flexible to allow both exact-solution and heuristic approaches and be scalable to accommodate geo-spatial heterogeneity—transportation networks, population distribution, service priorities, and community needs. We will leverage publicly available data such as Highway Performance Monitoring System (HPMS) and National Household Travel Survey Data (NHTS) to build our initial network and use scalable mesoscopic traffic flow models such as Cell Transmission Model (which can be embedded into mathematical programs) to build our solution

Case Study 2: Resilient, Safe Drinking Water Delivery – This Case Study seeks to transform existing models for water distribution system resiliency, which primarily address water pressure, to assess the continued disinfecting ability of treated water under disaster conditions. The objective of Case Study 2 is to develop optimization models to site disinfection booster systems to help manage water quality in drinking water distribution systems. The distribution system modeling framework will be based on EPANET and EPANET WNTR to incorporate classic pressure metrics along with disinfection, nitrate and pathogen concentrations. These models will also incorporate dependence on transportation, wastewater and stormwater collection, and electrical systems.

Case Study 3: Resilient Wastewater and Stormwater Collection – This Case Study seeks to integrate inundation, hydraulic, and stochastic collection system integrity modeling to assess worker safety and prioritize infrastructure enhancements. The objective of Case Study 3 is to develop stormwater and wastewater collection systems to model the impact of combined sewer and storm sewer collection system overflows on community resiliency. In the context of the other infrastructure systems, the models will be used to understand the barriers that these overflows will have on the ability to repair the systems during a disaster event.

Case Study 4: Distributed Energy Resources for Grid Resilience – This Case Study seeks to develop a heterogenous load clustering method utilizing demand-based dissimilarity index to increase social equity to manage energy hedging. Traditionally, both electric transmission systems and distribution systems are analyzed separately. In addition, the geographic limitations such as the direction of rooftop solar panels which impact the instantaneous generation are not included in the existing models. Since the interaction between transmission and distribution networks and geographical limitations would significantly affect the system resilience, this work will initially focus on developing appropriate transmission and distribution co-simulation models. This model will be built on a synthetic network and validated on data from both urban and rural network data that would be obtained through this project. This will be completed by Year 3.

The final objective in Theme 4 is to develop a heterogenous load clustering method utilizing a demand-based dissimilarity index to increase social equity to manage energy hedging. As part of this, an equity-driven energy policy framework will be developed in Year

4, which will consider pricing, quantity forcing policies, investment cost reduction policies, and public investments. By Year 5, a case study will be completed, which will show the impact of social-equity-driven policies using the SHFGT framework considering grid - transportation - water - natural gas (bulk for generation) infrastructure.

3. Theme 3: (T3) – Infrastructure Enhancement and Decision Levers: Case Studies

Goal 3. Quantify and analyze real-world relationships between hazards and infrastructure systems in short- and long-term decision-making scenarios for measuring how different decision levers influence social equity in Kansas communities.

- Objective 3.1 CS I: Transportation Management and Recovery Planning - Develop post-disaster route prioritization methods for restoration and recovery based on stochastic optimization techniques accounting for the trade-off between efficiency and equity objectives.
- Objective 3.2 CS II: Resilient, Safe Drinking Water Delivery - Transform existing models for water distribution system resiliency, which primarily address water pressure, to assess the continued disinfecting ability of treated water under disaster conditions.
- Objective 3.3 CS III: Resilient Wastewater and Stormwater Collection - Integrate inundation, hydraulic, and stochastic collection system integrity modeling to assess worker safety and prioritize infrastructure enhancements.
- Objective 3.4 CS IV: Distributed Energy Resources for Grid Resilience - develop a heterogenous load clustering method utilizing demand-based dissimilarity index to increase social equity to manage energy hedging.

Objective 3.1 Transportation Management	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 3.1a: Build transportation network (graphs) and demographic profiles for the two-testbeds (urban and rural) in Kansas	Compilation of publicly available geospatial datasets (road networks and population features) for the two testbeds.	i. Complete analysis of descriptive features of the datasets; ii. Identify the underserved communities (and respective demographic features) within the two testbeds.				**Aziz**, **Mendez**, 2 GRAs
Activity 3.1b: Define and formulate efficiency and equity metrics (and/or functions) to develop objective function(s) for post-	Complete synthesizing of equity and efficiency metrics relevant to post-disaster routing.	i. Develop equity metrics (and/or functions) for community resilience specific to post-disaster routing; ii. Define efficiency				**Mendez**, Aziz, 2 GRAs

disaster route prioritization		metrics--refined and revised through stakeholder feedback; iii. Identify the elements of uncertainties for efficiency and equity metrics.			
Activity 3.1c: Develop methodologies linking SHFGT architecture (Theme 1) and resilience analysis (Theme 2)	Complete understanding of the integration path-- metrics (3.1b) and SHFGT framework.	Finish integration of metrics into SHFGT architecture (Theme 1) and resilience analysis (Theme 2).			**Aziz**, **Mendez**, 2 GRAs
Activity 3.1d: Develop the stochastic optimization framework (mathematical program)		Formulate mathematical program(s) for post-disaster route optimization accounting for uncertainty.	Finish exploration of simulation-based optimization approaches.		**Aziz**, 1 GRA
Activity 3.1e: Build solution techniques for the stochastic optimization model-- heuristics and exact methods		Complete survey of solution techniques applicable to the mathematical program (heuristics and exact methods).	Output: Develop functional solution technique(s) to generate results.	Output: Develop alternative simulation-based solution technique.	**Aziz**, Mendez, 2 GRAs
Activity 3.1f: Develop policy analysis tool-- quantify the trade-off between efficiency and equityn objectives	Finish exploration of trade-off between efficiency and equity metrics relevant post-disaster routing prioritization.	Output: Develop mathematical models representing the trade-off between efficiency and equity-based performance function.	Integrate trade-off into the optimization model.	i. Complete trade-off analysis with diverse policy scenarios for the two test beds. ii. Output: Develop a ready-to-use tool for the decision-makers.	**Mendez**, Aziz, 2 GRAs

Objective 3.2 Safe Drinking Water	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 3.2a Identify target communities and their drinking water distribution inventories for use in the EPANET modeling software.	i. Identification of one community urban drinking water distribution system. ii. Collection of articles to synthesize review. Output: Review article on resiliency metrics for water quality in distribution systems.	i. Identification of one community using a rural drinking water distribution system. ii. Integration of drinking water distribution system inventories for urban water system into EPANET.	Integration of drinking water distribution system inventories for rural water system into EPANET.			**Peltier, Hutchison,** 2 GRAs
Activity 3.2b Model and quantify hydraulic pressure, water age, and threat associated with residual disinfectant breakdown in normal operations and disaster related events.		Water age and hydraulic pressure determination for urban water system under normal, disaster-related, and post-disaster-related operating conditions.	i. Water age and hydraulic pressure determination for rural water system under normal, disaster-related, and post-disaster-related operating conditions. ii. Threat determination with residual disinfectant breakdown for urban water system under same conditions.	Threat determination with residual disinfectant breakdown for rural water system under normal, disaster-related, and post-disaster-related operating conditions.		**Peltier, Hutchison,** 2 GRAs
Activity 3.2c Model infrastructure investment decisions (i.e., disinfection booster point installation) taking into account social equity metrics and integrate water related dependencies into SHFGT framework.		Integration of drinking water treatment and distribution system dependencies in SHFGT framework for urban water network.	Integration of drinking water treatment and distribution system dependencies in SHFGT framework for rural water network.	i. Model infrastructure improvements with and without social equity metrics in urban water network using multi-objective optimization. ii. Output: Optimal solution that incorporates social equity.	i. Model infrastructure improvements with and without social equity metrics in rural water network using multi-objective optimization. ii. Output: Optimal solution that incorporates social equity.	**Peltier, Hutchison, Natarajan,** Post Doc

Objective 3.3 Wastewater and Stormwater Collection	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 3.3a Model impact of wet weather and flooding on interdependent infrastructure systems when experiencing overflow events.	Collection of data on system infrastructure information for urban or rural systems.	Collection of data on system infrastructure information for urban or rural systems.	i. Mapping infrastructure systems in EPA's Storm Water Management Model (SWMM) for urban network. ii. Integration of interdependencing of sewer and combined sewer infrastructure with other systems.	Mapping infrastructure systems in EPA's Storm Water Management Model (SWMM) for rural network.	Output: Model infrastructure overflow events in urban and rural sites.	**Sharda, Hutchison, Natarajan,** 2 GRAs
Activity 3.3b Collect SSO/CSO events and flow data and map probability distribution function for SSO/CSO events.		Collection of SSO and CSO events in Kansas River corridor.	i. Mapping the probability of overflow event overlaid with other interdependent infrastructure systems. ii. Integrate the probability events of CSO/SSO with the SHFGT framework.			**Sturm, Kastens, Peltier,** GRA
Activity 3.3c Identify infrastructure improvements project in KCMO and KCK.			Collection of historical data on infrastructure improvement for collection systems in KCMO and KCK along with social equity considerations in the decision-making process.	Collection of historical data on infrastructure improvement for collection systems in KCMO and KCK along with social equity considerations in the decision-making process.	Output: Rank the efforts to incorporate social equity based decision making in the infrastructure improvement projects based on criteria developed in Theme 1 and 2 based on the project outcome.	**Sturm, Hutchison,** Peltier

Objective 3.4 Distributed Energy Resources for Grid Resilience	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 3.4a: Develop network model for the identified communities	i. Perform literature review on failure analysis for interdepended failures considering common mode failure. ii. Using electric data from the communities, develop a representative distribution network.	i. Develop equivalent network models for distribution systems with distributed energy sources. ii. Develop an optimal co-simulation platform for transmission and distribution network analysis with the focus on high impact low frequency events.				**Aravinthan**, Pahwa, Wang, 1 Post-Doc, 2 GRAs
Activity 3.4b: Understanding and modeling practical, policy, and attitudinal barriers grid resilience	Perform literature review about behavior considerations on power system impacts.	Develop a renewable energy policy framework to incorporate behavior limitations on power system operations.	Using the survey, tune the outcomes for the behavior impact framework.			**Wang**, Aravinthan, Pahwa, 1 Post-Doc, 2 GRAs
Activity 3.4c: Improve grid resilience considering grid - transportation - water - gas interdependence	Develop consumer centric power grid resilience metric.					**Pahwa**, Aravinthan, Wang, 1 Post-Doc, 2 GRAs
Activity 3.4d: Identify policy instruments required to adapt energy usage/supply during a disaster and propose a framework			i. Output: Complete developing the return on investment of roof top solar PVs based on the social and geographical disparity. ii. Clustered consumers based on the impact on their ability to support grid operations during a	Output: Complete developing an equity-driven energy policy that will consider pricing, quantity forcing policies, investment cost reduction policies and public investments.	Complete a case study that shows the impact of social-equity driven polices using SHFGT framework considering grid -	**Aravinthan**, Pahwa, Wang, 1 Post-Doc, 2 GRAs

				transportation - water - gas (bulk for generation) infrastructure.	
Activity 3.4e: Develop a system operational framework considering energy hedging	i. Perform literature review on grid operational framework during high impact low frequency events. ii. Output: Complete developing a model to quantify the cost of inconvenience to consumers.	Output: Complete developing a retail energy pricing model that values social equity, distribution system operational needs and quality of service for high impact low frequency events.	Output: Complete developing a retail market framework that incorporates relief to transmission network, return on investment and cost of inconvenience to consumers.	Output: Complete and validate an operational framework considering gas and transportation availably during high impact low frequency event.	**Aravinthan**, Pahwa, Wang, 1 Post-Doc, 2 GRAs

Research Outcomes and Capacity Building: Theme 3 will create an attributed geospatial dataset and planning tools that identify priority areas where high community inequity intersects with decision levers related to transportation route planning, water disinfectant stations, high bypass/overflow remediating, and energy grid resources distribution opportunities. Additionally, we will develop a geographically-linked list of risk mitigation options as an action-supporting supplement to the community risk map that, coupled with the SHFGT framework, will serve as a powerful planning tool for decision-makers to guide equity-driven infrastructure management and operations to enhance resilience. The CS results and tools will be shared with partnering organizations for immediate use (i.e., CS I – Kansas Department of Transportation (KDOT); CS II – KRWA, KDHE, Kansas American Water Works Association; CS III – KDHE, Kansas Water Office; CS IV – Evergy, Sunflower Electric, Kansas Corporation Commission, Southwest Power Pool).

Theme 4– Decision-Support Structure

The goal of the Theme 4: Decision Support Structure team is to *apply principles of behavioral economics to improve the choice architecture of the decision-support structure and demonstrate the decision-making framework to a diverse user base.* Theme 4 features several research tasks: 1) integrate experiments in the testbed survey waves, 2) conduct in-person experiments with community members, and 3) workshop trainings to evaluate and demonstrate IN-CORE usability with local policymakers. Data from these tasks will help inform the simulation capabilities of the decision support structure to better capture the human components of infrastructure engagement and decisions, as well as the structure's design to help support its utility with policymakers.

Theme 4 team members are summarized in Table 7. Contributing members from other project areas are also listed in Table 7.

Table 7. Theme 4 team members

Investigator	Title	Univ.	Expertise
Derek Reed (he), Theme Co-lead	Prof	KU	Behavioral economics, decision-making
Elaina Sutley (she), Theme Co-lead	Assoc Dean Diversity / Assoc Prof	KU	Social vulnerability measures, risk-based decision-making
George Amariucai (he)	Assoc Prof	KSU	Stochastic modeling
Jason Bergtold (he)	Prof	KSU	Economics, nonmarket valuation
Honghseng He (he)	Asst Prof	WSU	Machine learning, automation
Xiaoheng Wang (she)	Asst Prof	WSU	Public finance, capital asset management
Contributing investigators from other project areas			
Rachel Krause (she)	Prof	KU	Policy adoption, local government
Jomella Watson-Thompson (she)	Director / Assoc Prof	KU	Community capacity-building

The research team will design experiments to measure a) probability discounting, risk, ambiguity and loss b) social discounting and its relation to social equity, and c) consumer demand for disaster recovery and mitigation related to differing disaster events and infrastructure services. They will also provide Theme 1 with input on survey questions/designs to incorporate these experiments and data for a) municipal governments' capacity to engage decision support tools to Theme 2, and b) discounting, risk, demand, and behavioral responses to simulated policies to Themes 1 and 3. Information on demographics, resilience, and social equity will be used from Theme 1 research, as well as hazard and infrastructure scenarios from Theme 3 to help inform these tasks.

The research team will develop choice experiments and games to model decision support structure community decision-makers and end-users' responses to simulated policy efforts; they will also identify variations in target community decision-makers' and end-users' capacities to engage the decision support tool developed. Completion of CITI training on community-engaged research will be needed from all research team members.

The research team will identify community contacts for those in testbed communities most likely to serve as the end-user of the decision support tool. The research team will integrate ARISE research findings into IN-CORE. Accordingly, the team will need attendance to IN-CORE workshops from research team members.

4. Theme 4: (T4) – Decision-Support Structure

Goal 4. Apply principles of behavioral economics to improve the choice architecture of the decision-support structure and demonstrate the decision-making framework to a diverse user base.

- Objective 4.1 Understanding and Nudging Decision-Makers - translate existing socio-behavioral experimental approaches for quantifying risk tolerance/aversion, social discounting, and consumer demand for services - especially during disasters - to measure and address issues of infrastructure decisions and outcomes.
- Objective 4.2 Evaluate how choice architecture arrangements shape the public's expressed risk tolerance and demand for services in order to better inform the design of decision-support tools.
- Objective 4.3 Determine how the strategic capacity of communities and localities explains variance in engaging components of the decision-support tools.
- Objective 4.4 Decision-support Tool Implementation - Integrate ARISE research into a usable decision-support tool in order to demonstrate equity-driven infrastructure enhancement and capacity-building options to interested parties.

Objective 4.1 Understanding and Nudging Decision-Makers	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 4.1a: Design experiments to measure probability discounting and risk, social discounting and its relation to social equity, and consumer demand for disaster recovery/mitigation related to disaster events	i. Initial experimental protocols drafted. ii. Public events for data collection identified. iii. Contact lists drafted, and experiment sample developed.	i. Initial experiments field tested and conducted. ii. Preliminary analysis completed. iii. Gaps and opportunities identified, and experimental protocols revised.	i. Revised experiments conducted. ii. Analysis completed and Output: summary findings synthesized.	i. Final round of experiments conducted. ii. Statistical analyses conducted. iv. Output: Results across all 4.1.1 experiments synthesized and presented.		**Reed**, Bergtold (and team members: Krause, Wang, 1 Post-Doc, 4 GRAs)

Objective 4.2 Choice Architecture Arrangements	Specific Milestones					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 4.2a: Develop choice experiments and games to model responses to simulated policy efforts		i. Choice experiment and game protocols designed. ii. Identified public events and relevant sample for data collection	i. Initial experiments and games designed and tested. ii. Output: Preliminary analysis and report drafted.	i. Revised choice experiments/games conducted. ii. Output: Data analysis and report drafted.	i. Final round of choice experiments and games conducted. ii. Statistical analyses performed. iii. Output: surveys/games data and results synthesized and presented to partners.	**Bergtold**, Reed (and team members: Krause, Wang, 1 Post-Doc, 4 GRAs)
Activity 4.2b: Identity variations in capacities across KS communities				Analysis of state-wide municipal gov survey performed and communities that may lack capacity to engage the decision support tool identified.		**Bergtold**, Reed, Krause (and team members: Krause, Wang, 1 Post-Doc, 4 GRAs)

Objective 4.3 Strategic Capacity of Communities	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 4.3a. Identify who in testbed communities would be the best person to use the DM tool	i. Output: Community engagement CITI training module completed. ii. Testbed community contacts contacted and reconnected.		i. Testbed community contacts involved in initial experiments/ games. ii. Feedback gathered and integrated into next steps for tool. iii. Non-testbed communities identified and connected. iv. key contacts identified.			**Watson-Thompson** (and team members: Sutley, Bergtold, Krause, 2 Post-Docs, 2 GRAs)

Activity 4.3b. Identify community constraints and feasible solutions	Community engagement approach and tools for engaging with community members and representatives developed.				Community workshops conducted demonstrating IN-CORE and how it can improve city planning.	**Watson-Thompson** (and team members: Sutley, Bergtold, Krause, 2 Post-Docs, 2 GRAs)
Objective 4.4 Decision Support Tool Implementation	**Specific Milestones & Outputs**					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 4.4a. Integrate ARISE research into IN-CORE	i. IN-CORE demonstration for project team hosted.	i. Researchers met NCSA and IN-CORE Directors. ii. Priority criteria for moving ARISE algorithms into IN-CORE developed.	i. IN-CORE workshop for ARISE team. ii. Strategy and plan for model chaining developed.	i. IN-CORE workshop for ARISE team hosted. ii. Contributions incorporated into IN-CORE.	Demonstration of ARISE in IN-CORE provided to IPAC.	**Sutley** (and team members: He, Amariucai, 1 Postdocs, 3 GRAs)

Research Outcomes and Capacity Building: (1) Data and measurable relationships on the economics and behavioral economics of policy-maker and constituent values related to infrastructure decisions, and on risk tolerance and consumer demand for infrastructure concerns; (2) tools describing the various levers of behavior change to nudge decisions valued by all while protecting and enhancing social equity; and (3) functioning IN-CORE decision-support system with user interface, exemplified to user base in Kansas. The ARISE Co-Simulator in conjunction with IN-CORE can help identify future additions to the SHFGT model – and in this capacity, will become a valuable resource for guiding future infrastructure investments in Kansas. The team will leverage new transdisciplinary methods developed through Theme 4, and the decision-support tool and IPAC to pursue a suite of resilience- and smart-city based funding calls.

Education, Diversity & Workforce Development

The ARISE project builds a diverse and competitive workforce in project-related STEM fields by pursuing education and diversity objectives to connect with learners across the STEM learning ecosystem and foster CEnR. STEM learning opportunities in both formal and informal contexts will provide multiple entry points and levels of engagement for youth and families to explore project-related content and its relevance to their lives to help foster connections and create opportunities for extended engagement. Integrated components of coursework, research experiences, and community-informed training for emerging and established researchers will build a needed professional development framework for future engaged-scholarship.

Education, Diversity, and Workforce Development team members are summarized in Table 8.

Table 8. Education, Diversity, and Workforce Development team members

Investigator	Title	Univ.	Role
Claudia Bode (she), EOD	Education and Outreach Director	KNE	KNE EOD
Tim Pleskac (he), EO1 – KDSC Lead	Prof / Dept Chair	KU	EO1 – KDSC Lead
Lior Shamir (he)	Assoc Prof	KSU	EO1 – KDSC KSU site
Sergio Salinas-Monroy (he)	Assoc Prof	WSU	EO1 – KDSC WSU site
Jason Bergtold (he), EO2 – REU Lead	Prof	KSU	EO2 – REU Lead
Derek Reed (he)	Prof	KU	EO2 – KU REU site
Visvakumar Aravinthan (he)	Assoc Prof	WSU	EO2 – WSU REU site
Brenee King, (she), EO2 – KSU LSAMP Lead	Project Administrator	KSU	EO2 – KSU LSAMP Lead
Teresa MacDonald (she), EO3 Lead	Assoc Director NHM	KU	EO3 Lead
Jomella Watson-Thompson (she), EO4 – CEnR Lead	Director / Assoc Prof	KU	EO4 – CEnR Lead
Tonya Bronleewe (she), EO4 – WSU EFC	Director	WSU	EO4 – WSU EFC
Judith Smrha (she)	Dept Chair	Baker	EO1 – KDSC Baker site
Ana Maradiaga (she)	Asst Prof	Donnelly	EO1 – KDSC Donnelly College site
Janice Akao (she)	Prof and Dept Chair	Butler CC	EO1 – KDSC Butler CC site
Suzanne Smith (she)	Assoc Prof	JCCC	EO1 – KDSC JCCC site
Mary Patterson (she)	Data Science Module (Lead)	KCKCC	DO2 – KCKCC
Lisa Stoothoff (she)	Chief Operating Officer	Donnelly	EO1 – KDSC Donnelly College site
Emily Rountree (she)	Education Program Coordinator	KU	Community-engaged research
Elaina Sutley (she)	Assoc Dean Diversity / Assoc Prof	KU	Resilience course lead

Kansas Data Science Consortium (EO1)

Data science is a growing, interdisciplinary field that utilizes manual and computer-driven processes to analyze, visualize, and generate insights based on many kinds of data. The Kansas Data Science Consortium (KDSC) aims to expand the accessibility of data science in Kansas. Having skills in this area allows students to provide future employers with data-driven solutions to problems and questions in any industry. It also helps students be better consumers of information and news in their everyday life.
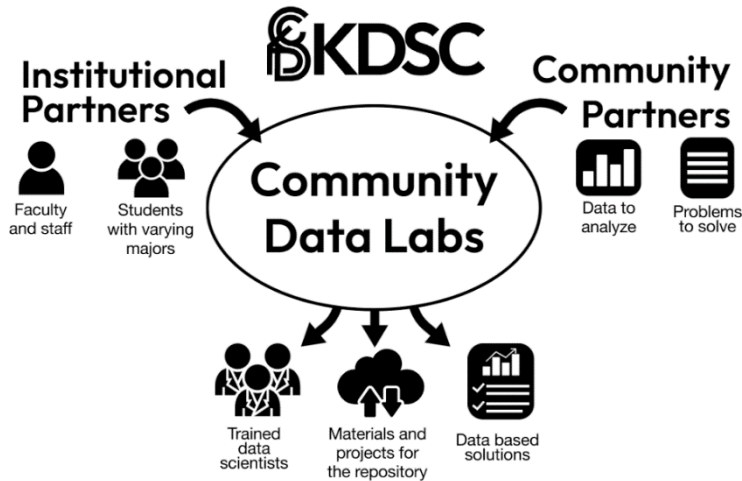
KDSC has two objectives. The first objective is to develop a data science capstone course called Community Data Lab (CDL). During this course, students will be connected with community organizations, municipalities, and businesses, from around Kansas to work on developing data-driven solutions for problems and questions they face. A distinguishing feature of these organizations is that they often lack the personnel and resources to pursue these solutions. Thus, the KDSC via the course will help expand the data science capacity in Kansas. At the same time, students will get hands-on experience working on these solutions helping build workforce capacity in Kansas. Starting in Year 1, the CDL course will be run at the University of Kansas, Kansas State, and Wichita State. Investigators from Johnson County Community College, Butler Community College, Baker University, and Donnelly College will be involved in developing the course with the goal that the course can be offered at their respective institutions in a form and structure that meets the needs of the students at their respective institutions. Then starting in Year 3, the CDL will be implemented at these colleges and universities and continue to be offered at the original three. We have also established a network of additional colleges that we will work to expand to offer the course at in Years 4 and 5. Besides developing a curriculum for the CDL, we will also develop summative and formative evaluations to assess the ability of the course to help build data science capacity in Kansas. '

The second KDSC objective is to build data science instructional capacity. To do so the KDSC will develop an online repository for data science curriculum material. Each year key personnel with the KDSC will be tasked with contributing one data science component to the KDSC repository. The material will be open source and tagged with the data science competencies that the component speaks to (e.g., data visualization). In addition, when possible, projects, data, and code from the CDLs across the state will be added to the repository.

Research Experiences for Undergraduates (EO2)

In meeting the objectives of training the next generation of scientists, a Research Experiences for Undergraduate (REU) program will be developed and conducted during Years 2, 3 and 4 of the ARISE project. The goal of the REU is to provide undergraduate

students with an intensive interdisciplinary research experience that provides valuable training in interdisciplinary research, data analytics, infrastructure and community resilience research, and social equity research, while affording the students an in depth understanding of the research process, interdisciplinary research environment, professional development, and opportunities for advanced studies and career paths. The program will directly interlink and involve the interdisciplinary research component of ARISE, having REU students work on research projects directly related to the research themes. We will recruit a diverse set of 10-12 undergraduate students per year. Students will be housed at KSU, KU and WSU and work directly with project researchers at each institution. Students will have training sessions, professional development activities, field trips, and site visits as a group, provided in-person and online. All students will produce a research poster and report that they will professionally present at the end of their REU program. The REU program will connect with other education and community outreach programs (e.g. LSAMP Program, data science education components, community outreach events, etc.) for training, professional development, esprit de corp, and experiential learning.

Kansas Louis Stokes Alliance for Minority Participation (EO2 & DO3)

The Kansas Louis Stokes Alliance for Minority Participation (KS-LSAMP) and Research Experience for Undergraduates (REU) aim to provide undergraduate research opportunities for minority and underrepresented students. Both programs will work in collaboration with ARISE faculty to help fulfill this goal. We plan to recruit students from existing programs and partner institutions that include minority serving institutions (MSIs), community colleges and other state colleges. Summer programs will be coordinated from May to July. In order for the programs to be successful we will need to identify faculty members who are willing and available during the program dates. These faculty will host students in their research areas in addition to other program requirements. Important dates/timelines are listed below:

- LSAMP (years 1-5)
    - Nov – applications open
    - Feb/March - applications close
    - April/early May - faculty-student pairing
    - June/July - summer program
- REU (years 2-5)
    - Nov to Jan – applications and marketing
    - Feb to March – program application closes/selection
    - April to May – program preparation
    - May to July – summer program
    - Aug to Oct – program assessment

Community Connections with TRIO and Libraries (EO3 & DO1)

The goal of this initiative is to build an interest in science and engineering among underserved youth populations, families, and communities in Kansas through a lens of resilience and socially relevant activities. This goal will be achieved by exploring

connections between infrastructure, the environment, wellbeing, and a community's response to hazards so that best practices can be shared with target populations in both urban and rural communities across the state.

The *Build Your Future* project focuses on engaging underrepresented 7th grade youth with STEM activities, role-playing games, and more to build their knowledge of, and preparedness for, hazardous events in Kansas such as floods, droughts, and tornadoes. This project will recruit students from the University of Kansas' TRIO "Talent Search" initiative; programing for *Build Your Future* consists of Saturday youth programs in the fall paired with family STEM outreach nights in the spring. Year 1 includes research and development of educational activities and games suitable for both event formats, while Years 2 through 5 will focus on program implementation. Additionally, recruitment of student (and family) cohorts for each program year ahead would occur in Years 1 through 4.

Connecting with rural and small Kansas communities via local libraries is another important aspect of the project. This portion of the project will occur in Years 4 and 5, in which activities developed for the TRIO program will be adapted, modified, and made bilingual (English/Spanish) for target audiences. Resources for implementing the modified activities as kit programs, including stipends for the partner libraries to purchase materials and host events, will be disseminated during Year 5.

During the first year of the project, it is vitally important that other Themes provide us with information to develop STEM- and resilience-related activities and games. We need the top 2-3 key takeaway messages that each Theme expects the public to remember about their portion of the project. In later years, participation in the spring family STEM outreach events (e.g., hosting a demo station), sharing connections, and helping with translation of activity materials from English to Spanish would assist in making our portion a success.

Community Engaged Research (EO4)

ARISE promotes community-engaged research (CEnR) by:
1. Enhancing capacity of researchers to engage authentically with community members in CEnR.
2. Broadening community engagement and outreach.
3. Developing training materials to assist communities in decision-making.

To enhance capacity for CEnR, ARISE has four key strategies. First, it requires researchers to complete CEnR training modules. Second, it offers Roundtables quarterly and monthly Deep Dives to provide technical support to put CEnR into practice. Third, ARISE employs Community Engagement Advocates who champion/broker community and campus partnerships. Finally, ARISE offers seed grants to support community engagement, as described below.

To broaden community engagement and outreach, ARISE is developing an approach for how to effectively engage communities based on a framework by the Institute of Medicine. It also is fully integrating research with community partners, documenting CEnR activities, developing a CEnR toolkit, and creating mapping tools for community engagement.

To assist communities and build public utility workforce capacity, ARISE is partnering with the Environmental Finance Center (EFC) at Wichita State University. The EFC will support the overall project effort by creating connections between research discoveries and community-level implementation, rolling-out findings and outcomes of this project in meaningful and practical ways. Specifically, the EFC will

- support testbed community engagement planning and communication throughout the five-year project,
- provide training(s) for the Science and Education Advisory Committee (SEAC), in years one and two, on public utility rates and finance, diverse workforce development, asset management, capital improvement planning, and other utility-related topics as needed,
- develop and implement Resiliency Tabletop Exercises, as a training for local utility staff and decision-makers, two each year in years four and five,
- develop and deliver conference presentations in years four and five (at least two each year), for utility professionals and municipal leaders.

Saturday Academy (DO2)

The goal of this theme is to expand KCKCC's Saturday Academy with new content focused on the data science of infrastructure. Saturday Academy is taught in 4 Module sessions on Saturdays to about 200 middle school and high school students, who provide feedback on each module per semester. One of the 4 modules is the Data Science Module. This Module will start in January of Year 1 by partnering with the EPA to allow students to gather real time air quality data at their homes. A singular live Google sheet will be provided to gather data. During Saturday Academy sessions, the data will be statistically analyzed and graphed by the students. In subsequent years the Data Science Module will be expanded to include the study of the electrical grid, the water infrastructure, and natural gas infrastructure of Kansas City, KS. Students will collect and analyze real time data relating to each infrastructure. A tour of the Nearman Water purifying plant will also be planned so that students can learn about water purification and distribution. Students will be taught the power of community involvement to improve the quality of the utilities that come to their homes, and they will also learn the power of the citizen scientist. Students will also be exposed to the various careers of data science, data analysis and infrastructure careers such as water quality technicians, electrical engineering, and civil engineering.

Seed Funding

To build research capacity, ARISE offers several seed funding opportunities to faculty at partner institutions. All awardees are required to participate in ARISE activities.

First Awards help early career faculty navigate the grant-writing process and initiate novel research. Two to three First Awards capped at $50K will be awarded each year in areas targeting resiliency and smart infrastructure. Since external experts in the field review these proposals, all submitters will gain valuable feedback that helps them enhance grantsmanship and compete nationally for funding. Research and Education Innovation (REI) Awards fund small projects to either i) network/plan, or ii) pursue larger

projects for transformational concepts related to resiliency. Annually, the Science and Education Advisory Committee and the ARISE project team will suggest topics to feature in the call for proposals. Two to four $50K REI awards are expected each year. Community-Engaged Research Awards (CEnR) fund teams of at least three researchers and a community advocate to undertake new case studies for Theme 3. Five $100K, two-year CEnR awards will be funded in Years 2-4. Disaster Response Grants allow scientists to respond quickly to disasters, much like an NSF RAPID award. Kansas researchers can propose projects up to $20K to collect ephemeral and longitudinal data relevant to the research. To streamline funding, the KNE Director and science leads will review submissions.

5. Education, Diversity and Workforce Development

Goal 5.1 Build a diverse and competitive workforce in project-related STEM fields.

- Objective 5.1.1 EO1 - Develop an interdisciplinary data science consortium that trains students on how to translate their skills and knowledge into data-driven solutions empowering Kansas businesses and organizations to make informed decisions.
- Objective 5.1.2 EO2 - Train the next generation of scientists by fostering an active resiliency research environment for diverse group of undergraduate and graduate students.
- Objective 5.1.3 EO3 - Engage youth and families through educational programming and resources that explore the connections between infrastructure, environment, and well-being.
- Objective 5.1.4 EO4 - Implement a network of community-engaged research and disseminate research to statewide workforce development initiatives / Connect to Community Needs.

Objective 5.1.1 Develop Data Science Consortium	Specific Milestones & Outputs					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 5.1.1a: Develop a data science capstone course called Community Data Lab (CDL)	i. Output: Establish CDL at KU, KSU, WSU, & best practices for working with community partners. ii. Host workshop and quarterly meetings with partner colleges. iii. Develop plan to add other colleges. iv Invite community partners. v. Develop methods for assessing curriculum. vi Output: Up to 20 undergrad and 20 grad students complete a CDL creating up to 10 community projects.	i. Offer CDL at KU, KSU, WSU. ii. Host workshop and quarterly meetings with partner colleges. iii. Expand community partners. iv. Assess curriculum. v. Output: Up to 12 undergrad and 20 grad students complete a CDL creating up to 10 community projects.	i. Add CDL at JCCC, Butler, Baker, and Donnelly and invite representatives from a larger network. ii. Host workshop and quarterly meetings with partner colleges. iii. Expand community partners. iv. Assess curriculum. v. Output: Up to 50 undergrad and 20 grad students complete a CDL creating up to 25 community projects	i. Continue offering CDL at 7 colleges and invite representatives from a larger network. ii. Host workshop and quarterly meetings with partner colleges. iii. Assess curriculum. iv. Output: Up to 50 undergrad and 20 grad students complete a CDL creating up to 25 community projects	i. Continue offering CDL at 7 colleges and invite representatives from a larger network. ii. Host annual workshop and quarterly virtual meetings with partner colleges. iii. Assess curriculum. iv. Output: Up to 50 undergrad and 20 grad students complete a CDL creating up to 25 community projects	**Pleskac,** Duncan (KU); Shamir (KSU); Salinas-Monroy (WSU); Smith (JCCC); Akao (Butler); Stoothoff, Maradiaga (Donnelly); Smrha (Baker)

Activity 5.1.1b: Establish an online repository for data science curriculum material	Output: Each KDSC institution prepares one teaching component to be shared to the to-be-developed online repository.	Outputs: i Create online repository; ii. Each KDSC institution contributes one teaching component beyond the CDL projects.	Output: Each KDSC institution contributes one teaching component beyond the CDL projects.	Output: Each KDSC institution contributes one teaching component beyond the CDL projects.	Output: Each KDSC institution contributes one teaching component beyond the CDL projects.	**Pleskac,** Duncan (KU); Shamir (KSU); Salinas-Monroy (WSU); Smith (JCCC); Akao (Butler); Stoothoff, Maradiaga (Donnelly); Smrha (Baker)
Objective 5.1.2 Train Undergraduate and Graduate Students	**Specific Milestones & Outputs**					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 5.1.2a: Host Research Experiences for Undergraduates (REU) at KU, KSU, WSU		i. Recruit students. ii. Engage up to 12 students in REU. iii. Participants make research posters, presentations, & reports. Output: Up to 12 undergrads receive research experience.	i. Output: Produce assessment report for Year 2 REU. ii. Recruit students. iii. Engage up to 12 students in REU. iv. Participants make research posters, reports & presentations. Output: Up to 12 undergrads receive research experience.	i. Output: Produce assessment report for Year 3 REU. ii. Recruit students. iii. Engage up to 12 students in REU. iv. Participants make research posters, reports & presentations. Output: Up to 12 undergrads receive research experience.	Output: Produce report and present findings on REU program experience.	**Bergtold** (KSU), Reed (KU), Aravinthan (WSU)
Activity 5.1.2b: Collaborate with Kansas LSAMP Program	Recruit & fund 1-2 undergrads to work with ARISE faculty during summer. Output: 1-2 undergrads receive research experience.	Recruit & fund 1-2 undergrads to work with ARISE faculty during summer. Output: 1-2 undergrads receive research experience.	Recruit & fund 1-2 undergrads to work with ARISE faculty during summer. Output: 1-2 undergrads receive research experience.	Recruit & fund 1-2 undergrads to work with ARISE faculty during summer. Output: 1-2 undergrads receive research experience.	Recruit & fund 1-2 undergrads to work with ARISE faculty during summer. Output: 1-2 undergrads receive research experience.	**King**
Activity 5.1.2c: Offer Multi-Institution Resilience Course for Graduate Students	Initiate informal seminar series for all researchers to learn ARISE topics	Continue informal seminar series	Output: Get resilience seminar course on the books at KU, KSU, WSU	Offer cross-institution resilience seminar course for graduate students	Offer cross-institution resilience seminar course for graduate students	**Sutley**

Objective 5.1.3 Engage Youth and Families	Specific Milestones & Outputs					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 5.1.3a: "Build Your Future" youth programs with KU TRIO	i. Obtain key takeaways for each theme (i.e., core ideas/concepts). ii. Research and develop youth program. iii. Outline program schedule with input from TRIO. iv. Create recruitment plan for YR2-5 with TRIO & recruit for YR2. v. Design, produce and source supporting materials (e.g., logo, books).	i. Output: Implement three 5-hr Saturday youth programs in Fall. ii. Recruit for YR3 participation.	i. Output: Implement three 5-hr Saturday youth programs in Fall. ii. Recruit for YR4	i. Output: Implement three 5-hr Saturday youth programs in Fall. ii. Recruit for YR5	i. Output: Implement three 5-hr Saturday youth programs in Fall. ii. KU TRIO shares program info & resources with other TRIO sites.	**MacDonald,** Gardner, Kocken
Activity 5.1.3b: Family STEM nights with TRIO	i. Research and develop outreach activities for family events. ii. Develop schedule and promotional plan with TRIO for YR2-5. iii. Outline plan and schedule for YR2.	i. Output: Implement three, 3-hour evening events at KCKCC or Donnelly College in the Spring. ii. Outline plan and schedule for YR3 events.	i. Output: Implement three, 3-hour evening events at KCKCC or Donnelly College in the Spring. ii. Outline plan and schedule for YR4 events.	i. Output: Implement three, 3-hour evening events at KCKCC or Donnelly College in the Spring. ii. Outline plan and schedule for YR5 events.	i. Output: Implement three, 3-hour evening events at KCKCC or Donnelly College in the Spring. ii. KU TRIO shares program info & resources with other TRIO sites.	**MacDonald,** Gardner, Kocken
Activity 5.1.3c: Community Connections through Public Libraries				i. Output: Adapt activities and create bilingual activity guides (with input from TRIO).	i. Output: Disseminate downloadable bilingual activity guides to public libraries. ii. Administer library stipends. iii. Share program info & resources with other TRIO sites. ties	**MacDonald,** Gardner, Kocken

Objective 5.1.4 Build Network of Community-Engaged Research	Specific Milestones & Outputs					
	Year 1-	Year 2	Year 3	Year 4	Year 5	Responsible Party
Activity 5.1.4a: Provide CITI Training for Community Engaged Research (CEnR) Module	i. Output: Create instructions for CEnR CITI training. ii. Team completes CEnR CITI training.	All new researchers complete CEnR CITI training.	All new researchers complete CEnR CITI training.	All new researchers complete CEnR CITI training.	All new researchers complete CEnR CITI training.	**Rountree** (and team members: Watson-Thompson, Sutley)
Activity 5.1.4b: Broaden Engagement and Outreach to community partners and partner institutions	i. Develop community engaged research approach for ARISE. ii. Host quarterly roundtable for researchers to learn and practice CEnR. iii. Provide monthly training and technical assistance. iv. Output: Launch tool for tracking community partner & engagement activities in Community Check Box (CCB).	i. Host quarterly roundtable for researchers to learn and practice CEnR. ii. Provide monthly training and technical assistance. iii. Track community activities in CCB. iv. Output: Develop and promote toolkit and mapping tool for community engagement.	i. Host quarterly roundtable for researchers to learn and practice CEnR. ii. Provide monthly training and technical assistance. iii. Track community activities in CCB. iv. Refine/promote toolkit and mapping tool for community engagement.	i. Host quarterly roundtable for researchers to learn and practice CEnR. ii. Provide monthly training and technical assistance. iii. Track community activities in CCB. iv. Refine/promote toolkit and mapping tool for community engagement.	i. Host quarterly roundtable for researchers to learn and practice CEnR. ii. Provide monthly training and technical assistance. iii. Track community activities in CCB. iv. Refine/promote toolkit and mapping tool for community engagement.	**Watson-Thompson** (and team members: Rountree, Center for Community Health and Development)
Activity 5.1.4c: Utilize Community Engaged Advocates (CEAs) to inform ARISE research	Engage up to 5 CEAs who lead up to 2 events per month, giving feedback to theme leaders to ensure participation of marginalized populations and tracking activities in CCB.	Engage up to 5 CEAs who lead up to 2 events per month, giving feedback to theme leaders to ensure participation of marginalized populations and	Engage up to 5 CEAs who lead up to 2 events per month, giving feedback to theme leaders to ensure participation of marginalized populations and tracking activities in CCB.	Engage up to 5 CEAs who lead up to 2 events per month, giving feedback to theme leaders to ensure participation of marginalized populations and tracking activities in CCB.	Engage up to 5 CEAs who lead up to 2 events per month, giving feedback to theme leaders to ensure participation of marginalized populations and	**Rountree** (and team members: Watson-Thompson, Sutley, Community Engagement Advocates)

		tracking activities in CCB.			tracking activities in CCB.	
Activity 5.1.4d: Build Public Utility Workforce Capacity by disseminating ARISE research findings and decision-making tools	i. Output: Develop 1 resiliency tabletop exercise; ii. Collect, develop, and disseminate resiliency information and resources through existing water workforce programs; iii. Provide water workforce promotional resources back to ARISE; iv. Provide at least 1 training session for SEAC & ARISE team.	i. Output: Develop 1 resiliency tabletop exercise; ii. Collect, develop, and disseminate resiliency information and resources through existing water workforce programs; iii. Provide water workforce promotional resources back to ARISE; iv. Provide at least 1 training session for SEAC & ARISE team.	i. Output: Develop 1 resiliency tabletop exercise; ii. Collect, develop, and disseminate resiliency information and resources through existing water workforce programs; iii. Provide water workforce promotional resources back to ARISE.	i. Offer 2 resiliency exercises locally or regionally; ii. Collect, develop, and disseminate resiliency information and resources through existing water workforce programs; iii. Provide water workforce promotional resources back to ARISE.	i. Offer 2 resiliency exercises locally or regionally; ii. Collect, develop, and disseminate resiliency information and resources through existing water workforce programs; iii. Provide water workforce promotional resources back to ARISE.	**Bronleewe**

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5. Education, Diversity and Workforce Development (cont.)

Goal 5.2 Build capacity for research and education by investing in people, community engagement, and ideas.

- Objective 5.2.1 Provide seed funding annually to faculty at partner institutions to build capacity within and beyond ARISE areas.

Objective 5.2.1 Provide Seed Funding	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 5.2.1a: First Awards	i. Distribute RFP in the fall. ii. Output: Award 2-3 faculty First Awards in the spring	i. Distribute RFP in the fall. ii. Output: Award 2-3 faculty First Awards in the spring	i. Distribute RFP in the fall. ii. Output: Award 2-3 faculty First Awards in the spring	i. Distribute RFP in the fall. ii. Output: Award 2-3 faculty First Awards in the spring	i. Distribute RFP in the fall. ii. Output: Award 2-3 faculty First Awards in the spring	**Management Team**
Activity 5.2.1b: Research and Education Innovation (REI) Awards	i. Distribute RFP in the fall. ii. Output: Award 2-4 faculty REI awards in the spring	i. Distribute RFP in the fall. ii. Output: Award 2-4 faculty REI awards in the spring	i. Distribute RFP in the fall. ii. Output: Award 2-4 faculty REI awards in the spring	i. Distribute RFP in the fall. ii. Output: Award 2-4 faculty REI awards in the spring	i. Distribute RFP in the fall. ii. Output: Award 2-4 faculty REI awards in the spring	**Management Team**
Activity 5.2.1c: Community-Engaged Research (CER) Awards		Output: Award 3 faculty CER awards	Output: Award 3 faculty CER awards	Output: Award 3 faculty CER awards	Output: Award 3 faculty CER awards	**Watson-Thompson,** Rountree, Management Team
Activity 5.2.1d: Disaster Response Grants	Only offered in case of disaster	Only offered in case of disaster	Only offered in case of disaster	Only offered in case of disaster	Only offered in case of disaster	**Management Team**

5. Education, Diversity and Workforce Development (cont.)

Goal 5.3 Increase participation of women, persons of color (particularly African Americans, Native Americans, and Hispanics), first generation college graduates, and researchers from rural Kansas backgrounds in STEM fields related to ARISE projects.

- Objective 5.3.1 DO1 - Create new programs for K-12 students and teachers from diverse Kansas areas that introduce them to resiliency science.
- Objective 5.3.2 DO2 - Build new partnerships with Kansas City, KS to expand STEM diversity initiatives to engineering.
- Objective 5.3.3 DO3 - Leverage the established KS-LSAMP, Haskell Environmental Research Studies Institute (HERS), and Emerging Scholars programs to recruit minority populations and expand opportunities with additional funds.

Objective 5.3.1 Create K-12 Programs	Specific Milestones & Outputs					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 5.3.1a: Create new K-12 programs with TRIO & libraries	(see above 5.1.3 for milestones)					**MacDonald,** Gardner, Kocken

Objective 5.3.2 Build New Partnerships	Specific Milestones & Outputs					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 5.3.2a Expand Saturday Academy program with new content	Output: Develop activities based on ARISE theme	Output: Develop activities based on ARISE theme	Output: Develop activities based on ARISE theme	Output: Develop activities based on ARISE theme	Output: Develop activities based on ARISE theme	**Patterson** (KCKCC)
Activity 5.3.2b Deliver Saturday Academies	i. Provide Saturday Academies with our theme. ii. Output: curriculum. iii. Survey participants to assess program. iv. Provide yearly modules with insights from participants.	i. Provide Saturday Academies with our theme. ii. Output: curriculum. iii. Survey participants to assess program. iv. Provide yearly modules with insights from participants.	i. Provide Saturday Academies with our theme. ii. Output: curriculum. iii. Survey participants to assess program. iv. Provide yearly modules with insights from participants.	i. Provide Saturday Academies with our theme. ii. Output: curriculum. iii. Survey participants to assess program. iv. Provide yearly modules with insights from participants.	i. Provide Saturday Academies with our theme. ii. Output: curriculum. iii. Survey participants to assess program. iv. Provide yearly modules with insights from participants.	**Patterson** (KCKCC)

Specific Milestones & Outputs

Objective 5.3.3 Recruit Under-represented Students	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 5.3.3a: Leverage LSAMP	(see above 5.1.2 for milestones)					**King**
Activity 5.3.3a: Leverage HERS	Inform Native interns about ARISE grad opportunities in June	Inform Native interns about ARISE grad opportunities in June	Inform Native interns about ARISE grad opportunities in June	Inform Native interns about ARISE grad opportunities in June	Inform Native interns about ARISE grad opportunities in June	**Bode**
Activity 5.3.3b: Leverage Emerging Scholars (KU) and Developing Scholars (KSU) programs	Faculty submit job descriptions in spring; Output: up to 2 undergrads at KSU & 5 at KU gain research experience.	Faculty submit job descriptions in spring; Output: up to 2 undergrads at KSU & 5 at KU gain research experience.	Faculty submit job descriptions in spring; Output: up to 2 undergrads at KSU & 5 at KU gain research experience.	Faculty submit job descriptions in spring; Output: up to 2 undergrads at KSU & 5 at KU gain research experience.	Faculty submit job descriptions in spring; Output: up to 2 undergrads at KSU & 5 at KU gain research experience.	**Bode, King**

Outcomes for Education, Workforce Development, and Diversity Activities and Capacity Building: Increased capacity of a diverse and competitive workforce in project-related STEM fields that connect with learners across the STEM learning ecosystem and foster community engaged research.

Partnerships and Collaborations

ARISE will leverage extensive partnerships and collaborations with 48 companies, municipalities, campus programs, and federal programs to strengthen and diversify the Kansas workforce, disseminate research and educational products, commercialize research and education products, and pave the way for economic development in Kansas. Exemplar partnership efforts are outlined below.

Data Science Consortium: More than 20 industry and organization partners have committed to participate in the KDSC. These organizations need a more educated data science workforce, and the KDSC will have an immediate impact within Kansas communities. A full-time project manager will manage and expand these partnerships.

Municipal and Utility Partnerships: The electric and water utilities that serve our testbed communities have agreed to serve on our IPAC (see letters from Evergy, Sunflower Electric). KDOT and local and state-wide emergency management agencies have also committed to support the project efforts (see letters from the Kansas Division of Emergency Management, Kansas Emergency Management Association, Ford County Emergency Management). Members from these partner agencies will participate in surveys, focus groups and interviews associated with Themes 1 and 2. Findings from the case studies in Theme 3 will be shared with these partners and their help will be solicited for the co-design of the decision-support tool in Theme 4.

Community Partnerships: The KU CEnR staff will provide research and community service expertise. A CEnR Partnership Coordinator will help identify and work with community engagement advocates and will ensure that campus partners respond rapidly to community requests and needs, which is critical to build and maintain trust. Faculty receiving seed funding for CEnR awards will work with the CEnR partnership coordinator. The partnership coordinator will also support aligning opportunities across funding initiatives and other resources to support continuity of funding and sustainability of partnership efforts over time.

Museum Partnerships: The proposed KUNHM science and engineering program builds on and extends existing partnerships with (i) KU's TRIO Talent Search program, expanding from one science workshop at the museum each summer to a year-round program of activities for youth and their families in Wyandotte County, and (ii) leverages relationships with underserved Kansas communities that have been developed through our mobile museum program that hosts outreach events in partnership with public libraries by providing STEM activities that they can integrate into their own programming for families.

Federal Partnerships: ARISE research outcomes will be incorporated into IN-CORE, an open-source software developed through a cooperative agreement between a team of academic researchers and the National Institute of Standards and Technology (NIST). Co-PI Sutley is one of the researchers in that cooperative agreement. ARISE research outcomes will be immediately available for use by IN-CORE users, including NIST researchers, other US Federal government agencies, and several state- and local jurisdictions. Separately, the ARISE team is partnering with the National Weather Service in Topeka (see letter) to collaborate on post-hazard assessments, and in sharing and analyzing relevant data.

6. Partnerships and Collaborations

Goal 6.1 Leverage extensive partnerships and collaborations with 48 companies, municipalities, campus programs, and federal programs to strengthen and diversify the Kansas workforce, disseminate research and educational products, commercialize research and education products, and pave the way for economic development in Kansas.

- Objective 6.1.1 Manage KDSC partnerships for curriculum development.
- Objective 6.1.2 Manage IPAC partnerships for research insight.
- Objective 6.1.3 Manage CEnR partnerships for community engagement.
- Objective 6.1.4 Manage outreach partnerships for broadening participation.

Objective 6.1.1 Manage KDSC Partnerships	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 6.1.1a Engage community partners for Community Data Labs (CDL)	9 partners engaged with CDL	12 partners engaged with CDL	12 partners engaged with CDL	16 partners engaged with CDL	Develop a working model for additional institutions to utilize the KDSC	**Pleskac**, Eason

Objective 6.1.2	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 6.1.2a Municipal and Utility Partnerships: Conduct surveys, focus groups and interviews associated with Themes 1 and 2	i. Community Partner and Contact list developed. ii. Community Engagement Advocate feedback on data collection methods. iii. Interviews and/or focus groups completed with relevant municipal interested parties in testbed site communities (2.1.2C). iv. Document activities with community partners	i. Share findings with municipal and utility partners from focus groups/surveys completed in community-friendly format (2.1.2C); ii. Communicate with the municipal contacts in testbed sites and regions introducing survey and learning more about the interest of the municipal contacts and/or representatives in this area (2.1.2C)	Obtain feedback from Community Engagement Advocates on testbed survey draft and pilot test with CEA. (2.1.2c)	Output: Share survey results and models/simulations to municipal contacts and community partners and representatives in community-friendly format	Communicate with the municipal contacts and community partners in other non-test bed sites in the regions to introduce survey and project and learn more about the interest of the municipal contacts and/or representatives in this area.	**Rountree** (and team members: Watson-Thompson, Sutley)

Activity 6.1.2b Community review and feedback on social equity measures based on literature review and interested parties meetings	i. Develop community engagement approach and tools for engaging with community members and representatives (Toolkit, CCB) (4.1.3b); ii. Engage community partners, including CEAs, in social equity metric data and planning, in conjunction with community capital measures (1.1.1a);	i. Support focus groups with testbed community interested party to develop relevant list of social equity metrics and indicators based on Activity 1.1.1a; ii. Share findings and proposed social equity measures with CE interested parties, including CEA in community-friendly format (1.1.1a); iii. Train CEA & Community Partner/IPAC to co-host focus group, reporting session (1.1.1a)	i. Support focus groups with testbed community interested parties to develop relevant list of social equity metrics and indicators based on Activity 1.1.1a; ii. Train CEA & Community Partner/IPAC to co-host focus group, reporting session (1.1.1a); iii. Share findings and proposed social equity measures with interested parties in community-friendly format (1.1.1a)	i. Share findings and proposed social equity measures with CE interested parties, including CEA in community-friendly format (1.1.1a); ii. Output: Provide community-friendly report and presentation to testbed communities of relevant household survey findings (1.1.1b)	Communicate with community partners in other non-test bed sites in the regions to introduce framework and approach	**Watson-Thompson**, Rountree

Objective 6.1.3	**Specific Milestones & Outputs**					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 6.1.3a Identify and work with community engagement advocates and will ensure that campus partners respond rapidly to community requests and needs	i. Identify two community engagement advocates (CEA) for each of the testbed site; ii. CEA provide feedback on activities; iii. Output: Community partner identification and contact database; iv. Community partner asset mapping based on contact database	i. CEA provide training as part of roundtables to researchers and academic partners; ii. CEA support two monthly activities to raise awareness and promote ARISE efforts. iii. Document community activities and partnership coordination support	i. CEA provide training as part of roundtables to researchers and academic partners; ii. CEA support two monthly activities to raise awareness and promote ARISE efforts. iii. Document community activities and partnership coordination support	i. CEA provide training as part of roundtables to researchers and academic partners; ii. CEA support two monthly activities to raise awareness and promote ARISE efforts. iii. Document community activities and partnership coordination support	i. CEA provide training as part of roundtables to researchers and academic partners; ii. CEA support two monthly activities to raise awareness and promote ARISE efforts. iii. Document community activities and partnership coordination support	**Rountree** (and team members: Watson-Thompson; Elaina Sutley, Emily Rountree (CSL); Community Partnership Coordinator)

Objective 6.1.4	**Specific Milestones**					

	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 6.1.4a Museum Partnerships: KU's TRIO Talent Search program to expand from one science workshop at the museum each summer to a year-round program of activities for youth and their families in Wyandotte County	See Activity 5.1.3a: "Build Your Future" youth programs with KU TRIO & Activity 5.1.3b: Family STEM nights with TRIO	See Activity 5.1.3a: "Build Your Future" youth programs with KU TRIO & Activity 5.1.3b: Family STEM nights with TRIO	See Activity 5.1.3a: "Build Your Future" youth programs with KU TRIO & Activity 5.1.3b: Family STEM nights with TRIO	See Activity 5.1.3a: "Build Your Future" youth programs with KU TRIO & Activity 5.1.3b: Family STEM nights with TRIO	See Activity 5.1.3a: "Build Your Future" youth programs with KU TRIO & Activity 5.1.3b: Family STEM nights with TRIO	**MacDonald,** Gardner, Kocken
Activity 6.1.4b Leverage relationships with underserved Kansas communities that have been developed through our mobile museum program	See Activity 5.1.3c: Community Connections through Public Libraries	See Activity 5.1.3c: Community Connections through Public Libraries	See Activity 5.1.3c: Community Connections through Public Libraries	See Activity 5.1.3c: Community Connections through Public Libraries	See Activity 5.1.3c: Community Connections through Public Libraries	**MacDonald,** Gardner, Kocken

Communication and Dissemination

ARISE will communicate and disseminate initiatives using several strategies to reach a broad and diverse audience that includes researchers, educators, students, community members, lawmakers, and other interested parties. KNE Education and Outreach Director (EOD) leads this effort with support from the entire team.

To communicate internally, the plan relies on a project listserv, electronic newsletters, frequent meetings, and digital tools (e.g., website, file sharing). To communicate both internally and externally to partners and other public audiences, KNE maintains social media using Twitter, Facebook, YouTube, LinkedIn, and Instagram. Electronic newsletters (e.g., MailChimp) will also be used to feature content for broader audiences.

To further enhance messaging, the plan features:
- Annual workshops to train researchers how to communicate science effectively.
- Annual meetings in partner communities, where statewide participants can learn about ARISE projects and university faculty can learn about Kansas culture/geography.
- Scholarly work published and presented locally, nationally, and internationally.
- Educational materials shared widely, leveraging the K-12 Science Education Program Consultant for Kansas. Continuing education for professionals will also occur at annual meetings and through activities at the Environmental Finance Center.
- Kansas libraries will gain bilingual outreach materials, impacting 2,400 families in Year 5.
- Short videos will highlight research and education results.
- An online toolkit with resources for community engagement will be hosted on a website that currently has over 6 million users annually.
- An interactive story map to show community engagement activities across the state.

7. Communication and Dissemination

Goal 7. Reach a broad audience of researchers, educators, students, interested parties, and the general public to promote ARISE research and education activities.

- Objective 7.1 Improve and expand the dissemination of ARISE scholarly output to interested parties and the scientific community.
- Objective 7.2 Improve and expand ARISE education and outreach activities dissemination

Objective 7.1 Disseminate Scholarly Outputs	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 7.1a Communicate ARISE initiatives to target audiences	i. Create plan for communications; ii. Create branded materials; iii. Launch website; iv. Create listserv; v. Create Microsoft Team; vi. Post twice weekly to social media; vii. Send newsletters (one/month internally; two/year broadly); viii. Outputs: Two videos and two press releases	i. Maintain website, listserv, and Microsoft Team; ii. Post twice weekly to social media; iii. Send newsletters (one/month internally; two/year broadly); iv. Outputs: Two videos; v. Review analytics and change tactics as needed.	i. Maintain website, listserv, and Microsoft Team; ii. Post twice weekly to social media; iii. Send newsletters (one/month internally; two/year broadly); iv. Outputs: Two videos; v. Review analytics and change tactics as needed.	i. Maintain website, listserv, and Microsoft Team; ii. Post twice weekly to social media; iii. Send newsletters (one/month internally; two/year broadly); iv. Outputs: Two videos; v. Review analytics and change tactics as needed.	i. Maintain website, listserv, and Microsoft Team; ii. Post twice weekly to social media; iii. Send newsletters (one/month internally; two/year broadly); iv. Outputs: Two videos; v. Review analytics and change tactics as needed.	**Management Team, Bode**
Activity 7.1b Train researchers how to communicate science	Pilot and develop workshop on Communicating Science	Host one workshop on Communicating Science, offered to researchers across Kansas, in addition to ARISE participants	Host one workshop on Communicating Science, offered to researchers across Kansas, in addition to ARISE participants	Host one workshop on Communicating Science, offered to researchers across Kansas, in addition to ARISE participants	Host one workshop on Communicating Science, offered to researchers across Kansas, in addition to ARISE participants	**Bode**
Activity 7.1c Host community-embedded statewide meetings		Host Annual Statewide Meeting in community in the spring	Host Annual Statewide Meeting in community in the spring	Host Annual Statewide Meeting in community in the spring	Host Annual Statewide Meeting in community in the spring	**Management Team**
Activity 7.1d Communicate scientific results		Outputs: Up to 10 publications; Up to 10 presentations	i. Outputs: Up to 12 publications; Up to 15 presentations; ii. Increase co-authorship networks for	i. Outputs: Up to 15 publications; Up to 20 presentations; ii. Increase co-authorship networks for	i. Outputs: Up to 20 publications; Up to 25 presentations; ii. Increase co-authorship networks	**All ARISE Investigators**

	publications (see external evaluation)	publications (see external evaluation)	for publications (see external evaluation)	

Objective 7.2 Disseminate Outreach Activities	**Specific Milestones & Outputs**				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 7.2a Disseminate education impacts and outreach	Meet with Kansas State Dept. of Education Science Education Program Consultant and see Activity 7.1.1a.	Disseminate TRIO Talent Search & Build Your Future and see Activity 7.1.1a.	See Activity 7.1.1a.	See Activity 7.1.1a.	See Activity 7.1.1a.	**Bode**
Activity 7.2b Expand Library Outreach to families in Kansas (see Activity 5.1.3c)					Outputs: i. Disseminate resources to libraries in Kansas. (Up to 2400 families served by end of YR5)	**MacDonald**
Activity 7.2c Disseminate ARISE activities, impacts and opportunities online	Announce funding, training, and outreach opportunities as described in Activity 7.1.1a (e.g., seed funding, REU, LSAMP, etc.)	Announce funding, training, and outreach opportunities as described in Activity 7.1.1a (e.g., seed funding, REU, LSAMP, etc.)	Announce funding, training, and outreach opportunities as described in Activity 7.1.1a (e.g., seed funding, REU, LSAMP, etc.)	Announce funding, training, and outreach opportunities as described in Activity 7.1.1a (e.g., seed funding, REU, LSAMP, etc.)	Announce funding, training, and outreach opportunities as described in Activity 7.1.1a (e.g., seed funding, REU, LSAMP, etc.)	**Bode**
Activity 7.2d Broadly disseminate Community Engagement Toolkit		Output: Create a Toolkit for the ARISE project using the Community Tool Box website	CEnR Seed Grant awardees use Toolkit.	CEnR Seed Grant awardees use Toolkit.	CEnR Seed Grant awardees use Toolkit.	**Rountree**
Activity 7.2e Communicate Community-engaged projects via interactive mapping		Output: Add communities served by ARISE to existing "Engaged KU" ArcGIS story map	Build story map for ARISE community engagement	Continue populating ARISE story map	Output: Complete ARISE story map	**Rountree**

Sustainability

The ARISE project will expand the research capacity in Kansas through strategic investments of personnel, collaboration-enhancing platforms, community partnerships, new research infrastructure, and education initiatives. The project has a three-part sustainability strategy: (1) develop a team of researchers and educators embedded within the Kansas community; (2) advance projects that foster sustainability; (3) generate non-EPSCoR funding.

Commitment to Team Building: To be sustainable, a research and training program like ARISE requires a strong network of researchers, educators, and community members. This is particularly important as the convergence research of ARISE requires diverse teams to work together that transcend disciplinary and organizational boundaries [302]. ARISE will pursue continuous team-building exercises, including team collaboration agreements, shared vision statements, community-embedded annual meetings with bus tours of Kansas infrastructure and institutions, and virtual bi-weekly sub-group meetings and monthly project team meetings. Part of these meetings will be dedicated to developing a shared language and terminology and reviewing successes and failures to promote a culture valuing diversity and a capacity for self-assessment. Finally, to further develop a strong and robust culture, ARISE will have mandatory trainings for community-engaged research and implicit bias.

Faculty Recruitment and Mentoring: Each assistant professor will be paired with a tenured faculty mentor, associate professors with full professors, and professors with peer mentors or senior administrators (e.g., department chairs, research center directors). Pairs will meet bimonthly during the first year of the project, with quarterly meetings thereafter. Each year, a structured peer mentoring guide will be created, and mentoring pairs will complete activities and reflections. These will encompass proposal writing strategies, funding connections, grad student recruiting and mentoring, stress management, and work-life balance, among other topics provided by guest speakers at annual ARISE workshops.

Sustainability of Project Activities: A sustainable research and training program requires adoption of strategies that ensure replicability and reproducibility at all levels. All research products, including non-RII data, the IRB protocol with amendments, the data collection instruments, deidentified data, and code files (e.g., Jupyter notebooks) will all be published on DesignSafe-CI, a multi-million-dollar NSF-funded cyber infrastructure for natural hazards engineering research. Each of these products will receive unique Digital Object Identifiers (DOIs) for other researchers to cite and utilize in their own work. Moreover, the operating decision-support model for Kansas decision-makers (Theme 4-2) will be implemented with the open-source (nonproprietary) software IN-CORE, allowing further development and modification of the model for other resilience science applications. Likewise, data, code, and other materials from the KDSC will, with permission, be cataloged and shared on a public repository.

Museum education and outreach efforts will extend beyond the project in several ways. The library activity guides will remain freely available to download on the project website, be linked from the KUNHM website, and shared via selected online activity databases (e.g., National Informal STEM Education Network). Activities developed for student and family programs will be available for use in other settings such as summer camps for future TRIO groups and other museum outreach events (e.g., Pop Up Science and Discovery Day series). After the project, the Environmental Finance Center will continue to use the research findings and decision-

making tools in its work providing support to communities as they tackle environmental and environmental finance challenges. Continued implementation of resilience tabletop exercise, resilience conference presentations, and other materials informed by this project is expected.

Post RII Track-1 Extramural Funding: We have three specific strategies to increase competitiveness of funding applications. (1) All First Awards applicants will prepare an NSF-formatted proposal and receive external, disciplinary reviews. Applicants (both funded and not funded) will be encouraged to revise and submit an NSF CAREER proposal, and KNE will partner with the research development offices at KU, KSU, and WSU to promote grant development programs being offered. ARISE researchers will serve as mentors. (2) The ARISE team will identify emerging research topics for REI Awards, which will provide resources for collecting preliminary data. All REI awardees will be asked to develop external grant applications, and the KNE office will assist in finding opportunities. (3) Team-building and training exercises will be held at each two-day annual in-person ARISE project meeting. Rotating members of the project team will be responsible for investigating and presenting external funding opportunities to the team members, strategizing what aspects and personnel of the ARISE project are best positioned to pursue it, and presenting this information in an open-discussion format session on the second day of the meeting. Monthly project leadership meetings will follow up with prospective applicants to coordinate support and develop targeted timelines and goals for submission.

ARISE research will be used to stimulate multi-directorate NSF proposals, with initial targets for the Civic Innovation Challenge, Harnessing the Data Revolution, Strengthening American Infrastructure, and Smart and Connected Communities. There has been a Dear Colleague Letter encouraging collaboration among Computer and Information Science and Engineering (CISE) and Social, Behavioral, and Economic Sciences (SBE) directorates. Collaborations between ARISE researchers in these areas will position the jurisdiction to be more competitive for these funding opportunities.

The KDSC has a three-part sustainability plan. As the KDSC develops, it will transition to a fee plan with its community partners- one that reflects the varying levels of resources for the partners. By Year 3, the KDSC investigators will submit an NSF Research Traineeship (NRT) focused on integrating public policy into data science. The KDSC will facilitate the development of data science programs at smaller colleges and community colleges via networks of faculty and resources across schools, including the online data science course material. In years 4 and 5, the KDSC will apply for an NSF Improving Undergraduate STEM Education (IUSE) and other STEM development grants, focused on reaching first generation and continuing education students. We will work with our HSI partners to prepare proposals for the IUSE:HSI program. We will target 5 submissions by Year 2 ($1.5M) and 10 submissions/yr in Years 2-5 ($5M/yr).

8. Sustainability

Goal 8. Expand the research capacity in Kansas through strategic investments of personnel, collaboration-enhancing platforms, community partnerships, new research infrastructure, and education initiatives.

- Objective 8.1 Develop a team of ARISE researchers and educators embedded within the Kansas community through team-building, faculty recruitment, and mentoring.
- Objective 8.2 Advance projects that foster sustainability that adopt strategies that ensure replicability and reproducibility at all levels.
- Objective 8.3 Generate non-EPSCoR funding using specific strategies to increase competitiveness of funding applications.

Objective 8.1 Develop Research Team	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 8.1a Develop team collaboration agreements and shared vision statements	Agreements and statements developed	Revisit and revise as needed	Revisit and revise as needed	Revisit and revise as needed	Revisit and revise as needed	**ARISE Theme Leaders**
Activity 8.1b Hold community-embedded annual meetings	Annual meeting held in the Spring	i. Annual meeting held in the Spring; ii. Bus tours of Kansas infrastructure and institutions	i. Annual meeting held in the Spring; ii. Bus tours of Kansas infrastructure and institutions	i. Annual meeting held in the Spring; ii. Bus tours of Kansas infrastructure and institutions	Annual meeting held in the Spring	**Management Team**
Activity 8.1c Hold virtual bi-weekly sub-group meetings and monthly project team meetings	Meet bi-weekly for sub-groups and monthly for project team.	Meet bi-weekly for sub-groups and monthly for project team.	Meet bi-weekly for sub-groups and monthly for project team.	Meet bi-weekly for sub-groups and monthly for project team.	Meet bi-weekly for sub-groups and monthly for project team.	**ARISE Theme Leaders**
Activity 8.1d Have mandatory trainings for community-engaged research and implicit bias	See Activity 5.1.4a	See Activity 5.1.4a	See Activity 5.1.4a	See Activity 5.1.4a	See Activity 5.1.4a	**Rountree**
Activity 8.1e Faculty Mentoring: Pairs of un-tenured and tenured faculty will meet regularly	Bimonthly during the first year of the project / Create a structured peer mentoring guide	Quarterly meetings held; Create a structured peer mentoring guide	Quarterly meetings held	Quarterly meetings held	Quarterly meetings held	**ARISE Theme Leaders**

Objective 8.2 Foster Sustainability of Project Outcomes	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 8.2a Make ARISE research products shareable and publicly available (with permission)	Products published on DesignSafe_CI	Operating decision- support model implemented with IN-CORE	KDSC materials cataloged and share in a public repository	KDSC materials cataloged and share in a public repository	KDSC materials cataloged and share in a public repository	**Sutley, Plescak**
Activity 8.2b Make activities developed for student and family programs available for use in other settings			Output: Share materials with other TRIO sites in Kansas as they become available.	Output: Share materials with other TRIO sites in Kansas as they become available.	Output: Share materials with other TRIO sites in Kansas as they become available.	**KU TRIO partner,** MacDonald
Activity 8.2c Make library activity guides freely available to download					Output: Share materials as they become available on project website, KU natural history museum website, and other databases such as National Informal STEM Education Network.	**MacDonald**

Objective 8.3 Increase Funding Competitiveness	Specific Milestones & Outputs					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 8.3a Promote grantsmanship among early-career faculty (see Activity 5.2.1a)	i. First Award RFP released in the fall; II. Up to 4 First Awards made.	i. First Awardees submit NSF proposals; ii. First Award RFP released in the fall; iii. Promote grant development opportunities being offered; iv.Up to 4 First Awards made.	i. First Awardees submit NSF proposals; ii. First Award RFP released in the fall; iii. Promote grant development opportunities being offered; iv.Up to 4 First Awards made.	i. First Awardees submit NSF proposals; ii. First Award RFP released in the fall; iii. Promote grant development opportunities being offered; iv.Up to 4 First Awards made.	i. First Awardees submit NSF proposals; ii. First Award RFP released in the fall; iii. Promote grant development opportunities being offered; iv.Up to 4 First Awards made.	**Sturm**, Byers
Activity 8.3b Identify emerging research topics for REI Awards (see activity 5.2.1b)	i. REI Award RFP released in the fall; ii. Up to 4 new REI Awards made.	i. REI awardees submit external grant applications; ii. REI Award RFP released in the fall; iii. Up to 4 new REI Awards made.	i. REI awardees submit external grant applications; ii. REI Award RFP released in the fall; iii. Up to 4 new REI Awards made.	i. REI awardees submit external grant applications; ii. REI Award RFP released in the fall; iii. Up to 4 new REI Awards made.	i. REI awardees submit external grant applications; ii. REI Award RFP released in the fall; iii. Up to 4 new REI Awards made.	**Sturm**, Byers
Activity 8.3c Conduct team-building exercises to identify external funding opportunities	i. Training, strategizing at 2-day project meeting; ii. Targeted timelines and goals for submission.	i. Training, strategizing at 2-day project meeting; ii. Targeted timelines and goals for submission.	i. Training, strategizing at 2-day project meeting; ii. Targeted timelines and goals for submission.	i. Training, strategizing at 2-day project meeting; ii. Targeted timelines and goals for submission.	i. Training, strategizing at 2-day project meeting; ii. Targeted timelines and goals for submission.	**All ARISE Investigators**
Activity 8.3d Stimulate multi-directorate NSF/ federal agency proposals	NSF/federal funding programs identified	i. Up to 5 NSF/ federal proposals submitted. ii. Funding programs identified.	i. Up to 10 NSF/ federal proposals submitted. ii. Funding programs identified.	i. Up to 15 NSF/ federal proposals submitted. ii. Funding programs identified.	Up to 20 NSF/ federal proposals submitted.	**All ARISE Investigators**
Activity 8.3e KDSC expansion			Transition to fee plan	Data science programs at smaller and community colleges		**Pleskac**
Activity 8.3f KDSC targeted funding			i. Submit NRT.	i. Submit IUSE and other STEM development grant.	i. Submit IUSE and other STEM development grant.	**Pleskac**

Management, Evaluation, and Assessment

ARISE management, evaluation, and assessment is divided into two goals, 1) effective management and oversight of the overall project, and 2) methods for collecting, tracking, and reporting project progress as well as external evaluation and assessment. **Overall project management** objectives include creating an effective environment for management, coordination and bi-directional communication between the Management Team (MT) and project participants and interested parties. This includes engaging expertise and guidance from advisory councils, industry and test-bed community experts. The MT will meet monthly to discuss the progress of the project, provide general management, and to plan and prepare for larger meetings and site visits. The MT consists of the two Co-PIs and representative theme leaders for the research projects, *Natarajan* (KSU), *Sutley* (KU), *Aravinthan* (WSU), *Bergtold* (KSU), *Krause* (KU); the lead investigators for KDSC, CEnR, REU, *Pleskac* (KU), *Watson-Thompson* (KU), *Bergtold* (KSU); and the KNE PD, *Sturm*, PA, *Byers*, and EOD, *Bode* (KNE). In addition, ARISE team leaders, researchers, and students will hold biweekly research meetings for each of the research or outreach areas, with larger inter-group meetings convened every two months.

Project feedback will be obtained from groups formed for specific purposes. The Post-doc and Student Leadership Group (PSLG) will be formed from three representatives from each campus, with postdocs, graduate, and undergraduate students represented. This group provides direct feedback to project management and will enable a sense of community across the project. The Science and Education Advisory Committee (SEAC) provides objective scientific and education input and guidance. This committee will be informed by a yearly external evaluation and will provide input on a) progress toward goals and objectives, b) necessary adjustments as the project progresses, and c) feedback on reverse site visits. The Interested Party Advisory Council (IPAC) includes representatives from the testbed communities involved in the research initiatives, including utility service providers, industry consultants, city/state administrators, planner and emergency management staff, and representatives from social organizations that serve to inform ARISE research.

The purpose of the **external evaluation** is to support the development and assess outcomes of the Kansas EPSCoR Track 1 project through formative and summative input across the five years of cooperative agreement. The evaluation addresses the different components of the project including collaboration, data collection, training and workforce development, diversity, production and research, and other outcomes. In the first year of the project, the evaluation team (Welch and Britton) will develop the five-year evaluation plan for the ARISE project. The evaluation plan is considered a living document as some adjustments to the evaluation are expected due to normal adjustment across the five years of the project. The evaluation is guided by key questions tied to project goals, activities, outputs, intended outcomes, and impacts. Evaluation questions serve as a foundation for the development of concepts identified in the project logic model and operationalized through all data collection efforts including the design and administration of interview protocols and survey instruments. Each year the evaluation team will collect data to inform project performance and progress toward accomplishment of goals and objectives. Data will include: 1) administrative data collected by the ARISE management team; 2) in person and online interviews of the ARISE leadership and other key members of the ARISE team across research theme, academic position/rank, discipline and institution; 3) observation of ARISE management meetings as needed; 4) attendance of the annual ARISE All Hands meetings; 5) online surveys of ARISE faculty, postdocs and students; and 6)

case studies providing more detailed assessments of progress in specific aspects of the ARISE project; and 7) ARISE publication and proposal data. Synthesis of qualitative and quantitative data collected each year will inform the questions and provide feedback and advisory recommendations. Drs. Welch and Britton will maintain close communication with the project PI and other leads and will attend ARISE management meetings on a regular basis.

9. Management, Evaluation, and Assessment

Goal 9.1 Oversee and guide the project in a way that supports research and education, builds collaborative relationships, strengthens institutional research infrastructure, and develops leadership skills.

- Objective 9.1.1 Implement a Project Management structure to provide effective and efficient operation and supervision of Kansas NSF EPSCoR projects.
- Objective 9.1.2 Utilize advisory councils to provide objective scientific, education, industry, interested party, and community expert input and guidance.

Objective 9.1.1 Implement a Project Management Structure	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 9.1.1a Management Team (MT) provides effective project guidance/management	i. MT meets monthly. ii. Larger group meets every other month.	i. MT meets monthly. ii. Larger group meets every other month. ii. Prepare for and attend NSF Reverse Site Visit	i. MT meets monthly. ii. Larger group meets every other month.	i. MT meets monthly. ii. Larger group meets every other month. ii. Prepare for and host NSF Site Visit in Kansas	i. MT meets monthly. ii. Larger group meets every other month.	**Management Team**
Activity 9.1.1b Post-doc and Student Leadership Group (PSLG) provides feedback and informs ARISE MT	i. Form Leadership Group; ii. Develop system for obtaining PSLG feedback.	i. Poster session at annual statewide meeting; ii. Obtain PSLG feedback to inform MT.	i. Poster session at annual statewide meeting; ii. Obtain PSLG feedback to inform MT.	i. Poster session at annual statewide meeting; ii. Obtain PSLG feedback to inform MT.	i. Poster session at annual statewide meeting; ii. Obtain PSLG feedback to inform MT.	**Theme Leaders**

Objective 9.1.2 Utilize Advisory Councils	Specific Milestones & Outputs					
	Year 1	Year 2	Year 3	Year 4	Year 5	Responsible party
Activity 9.1.2a Obtain objective scientific and education input and guidance from the SEAC	i. Charge SEAC with review of research and education projects; ii. SEAC meets annually at statewide meeting followed by a report and ARISE response.	SEAC meets annually at statewide meeting followed by a report and ARISE response.	SEAC meets annually at statewide meeting followed by a report and ARISE response.	SEAC meets annually at statewide meeting followed by a report and ARISE response.	SEAC meets annually at statewide meeting followed by a report and ARISE response.	**Management Team**
Activity 9.1.2b Utilize IPAC to incorporate diverse interested party perspectives into resilience research	i. Introductory meeting with IPAC; ii. Develop system for obtaining IPAC feedback.	i. Hold IPAC meeting; ii. Obtain IPAC feedback to inform Theme Leaders.	i. Hold IPAC meeting; ii. Obtain IPAC feedback to inform Theme Leaders.	i. Hold IPAC meeting; ii. Obtain IPAC feedback to inform Theme Leaders.	i. Hold IPAC meeting; ii. Obtain IPAC feedback to inform Theme Leaders.	**Theme Leaders**
Activity 9.1.2c Utilize Community Engagement Studios to provide feedback and inform ARISE from a community perspective	i. Convene panel of community experts; ii. collect feedback to inform ARISE investigators.	i. Convene panel of community experts; ii. collect feedback to inform ARISE investigators.	i. Convene panel of community experts; ii. collect feedback to inform ARISE investigators.	i. Convene panel of community experts; ii. collect feedback to inform ARISE investigators.	i. Convene panel of community experts; ii. collect feedback to inform ARISE investigators.	**Theme Leaders**

Goal 9.2 Integrate formative and summative evaluation and assessment components to form a feedback system that assists KNE to successfully attain the full range of proposed goals and objectives set out in the ARISE project.

- Objective 9.2.1 Develop and implement a performance tracking process designed around NSF annual report metrics and external evaluation needs.
- Objective 9.2.2 Implement a mixed-method evaluation methodology to provide feedback to KNE about performance and progress.

Objective 9.2.1 Develop a Performance Tracking Process	Specific Milestones & Outputs					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 9.2.1a Collect and track ongoing performance metrics	i. Acquire/develop and implement reporting system; ii. Output: Prepare and submit annual report by 3/1.	i. Implement reporting system; ii. Output: Prepare and submit annual report by 3/1.	i. Implement reporting system; ii. Output: Prepare and submit annual report by 3/1.	i. Implement reporting system; ii. Output: Prepare and submit annual report by 3/1.	i. Implement reporting system; ii. Output: Prepare and submit final annual report by 6/1.	**Byers,** Management Team

Objective 9.2.2 Provide Feedback to KNE	Specific Milestones & Outputs					
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Responsible party**
Activity 9.2.2a Develop External Evaluation Plan	i. Initial planning & evaluation development; baseline survey; ii. Plan submitted to NSF for approval.	Output: Plan approved by NSF.				**Welch**, Britton
Activity 9.2.2b Annual assessment of overall project performance	i. Initial review of project implementation and early progress; ii. Baseline faculty survey; iii. Output: Evaluation report by 3/1.	i. Year-round review; ii. Case analysis; surveys; 1-2 site visits; iii. Output: Evaluation report by 3/1.	i. Year-round review; ii. Case analysis; surveys; 1-2 site visits; iii. Output: Evaluation report by 3/1.	i. Year-round review; ii. Case analysis; surveys; 1-2 site visits; iii. Output: Evaluation report by 3/1.	i. Year-round review; ii. Case analysis; surveys; 1-2 site visits; iii. Output: Evaluation report by 3/1.	**Welch**, Britton
Activity 9.2.2c Communication and interaction with KNE Office; attendance of MT meetings	i. MT meeting attendance; ii. Regular/as-needed communication with PI.	i, MT meeting attendance; ii. Regular/as-needed communication with PI.	i, MT meeting attendance; ii. Regular/as-needed communication with PI.	i, MT meeting attendance; ii. Regular/as-needed communication with PI.	i, MT meeting attendance; ii. Regular/as-needed communication with PI.	**Welch**, Britton
Activity 9.2.2d Feedback loop	MT report/response review/action.	MT report/response review/action.	MT report/response review/action.	MT report/response review/action.	MT report/response review/action.	**Welch**, Britton

Risk Management Plan

Likelihood	Impact	Description	Mitigation	Lead(s)
High	High	Many dependencies, linkages, inputs/outputs from one task to another. (1) Some are known, some are not well understood; (2) a delay in one could cause substantial delay down the road for another.	Strategic planning meeting; revisit for recalibration quarterly; Develop flow chart showing inputs/outputs across tasks (in Microsoft Project) in Year 1; Could bring project management professional onto leadership team (Nevada example).	Bala Natarajan
High	High	Challenges exist in working with new collaborators.	Team-building exercises; Manage expectations; Creating grad student leadership council; Creating culture for work and collaboration through communities to introduce new members and providing a platform; Developing and sharing an onboarding document.	Belinda Sturm
High	High	(Theme 3) Data from infrastructure systems have different temporal, spatial and measurement scales, which will need to be integrated for a common analysis platform.	Need each theme to outline data needs by end of Year 1; Need to gather example datasets and discuss aggregation and disaggregation methods by Year 2; outline data management plans. Revisit data management each annually.	Each theme will have a data committee member who will interface the project manager; project- wide responsibility.
High	High	(KDSC) Diversity in the KDSC is a weakness in that we have to find a common language, procedures, etc to work across the KDSC.	Establish monthly meetings, common work platform (i.e., Teams and GitHub)	Tim Pleskac
High	High	Loss of expertise due to poaching of faculty, and other project personnel to other institutions.	Cross train individuals within and across themes; Develop common work platforms to share resources and create institutional memory, develop contingency plan for loss of personnel; Allow budget flexibility to hire technical staff as needed or support faculty recruitment by partnering with department chairs; In Year 3, an Associate Project Director will be identified to train under PD Sturm. The Assoc PD will attend project team meetings and annual NSF visits and will assist with the management of ARISE.	Sturm, Theme Leaders

High	High	(Theme 2) Increasingly low response rates on surveys -- may hinder ability to do reliable network analysis.	Budget additional time/resources for survey follow-up. Establish alternative gather network data (such as through identifying shared venue connections) and/or utilize imputation/synthetic data. We already have budgeted for incentives (for community surveys only), but may need more. Clearly communicate significance of their response.	Rachel Krause
High	High	(KDSC) Dispute over intellectual property. During the Community Data Lab students will develop solutions, data, formulae, computer software, products, processes, technologies, etc. Confusion can arise over who owns this intellectual property.	Develop an agreement for the Community Partner and the Community Data Lab students and staff sign establishing ownership of the intellectual property.	Tim Pleskac, Will Duncan, Gryffin Eason
High	High	(CEnR) How we define and work with community partners as a team – are we on the same page? When do we need commonalities? When are MOUs necessary?	Complete CITI CEnR modules so academic partners have general and common understanding of community engagement. Develop and expand the Community Engagement Toolkit to provide resources and templates (e.g., MOU) for working with community partners based on the Community Tool Box (ctb.ku.edu). Facilitate community engagement roundtables to provide training and dialogue on community engagement. Provide ongoing supports and technical assistance through optional deep dive activities for those needing to explore more.	Jomella Watson-Thompson, Emily Rountree
High	High	(CEnR) How we work with partners and communicate with community partners, both internally and externally – points of contacts and internal management of community partner interactions	Document, track, and provide reports to collaborators on partner interactions, contacts, and partnerships, including the key lead from the project. Document community engagement and partnership activities in the Community Check Box Evaluation System to examine type, frequency, and intensity of partnerships. Coordinate with management team and theme leaders to identify and support partnerships.	Jomella Watson-Thompson, Emily Rountree

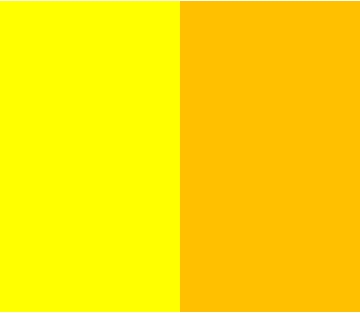|				
High	High	(CEnR) Sustainability threats – continuity of projects, partnerships, educational aspects, etc.	Identify and track needs of partners and interested parties and brokering supports by partners. Facilitate tracking and mapping of community-engaged projects and activities across the state. Support community engagement advocates in identifying needs and brokering partnerships. Facilitate roundtable on sustainability tactics for CEnR.	Jomella Watson-Thompson, Elaina Sutley
High	Medium	Convergence aspect of research directions are new for many participating investigators. While there are experts on relevant disciplines/topics (E.g., community engagement), there are also limitations in interdisciplinary and breadth of knowledge across all/many areas for ARISE researchers. This may slow the process of getting started together.	Team members will develop shared lexicon and opt into learning and/or training opportunities.	Elaina Sutley
High	Medium	Disciplinary, subject matter and method knowledge gaps exist, such as SHFGT framework, specific infrastructure knowledge and qualitative research methods, emergency management, and disaster and resilience planning.	Host internal seminar series during the entire project period; Develop interdisciplinary knowledge repository in year one (ongoing); Workshops associated with annual meetings; Recruit post-docs with complementary and needed social science expertise, including disaster and resilience planning, behavior science, and sociology; Seed funding programs will enable us to recruit new team members that help fill any identified gaps in expertise and research needs.	Each theme will have a committee who will interface the project manager; project wide responsibility
High	Medium	(KDSC) There are different levels of student experience and expertise across the schools.	Hold annual workshops to learn from each other, develop knowledge, skills, and abilities map to understand different experience and expertise.	Tim Pleskac, Will Duncan & Gryffin Eason
High	Medium	(KDSC) The course has not been taught at all sites.	Have proper staffing for the course, begin planning in the fall semester.	Will Duncan, Lior Shamir, Sergio Salinas Monroy
High	Medium	Inflation - Projects costs will be higher than expected.	Funds may need to be reallocated from project areas underspent	Theme Leaders

High	Medium	IRB offices have been slow to review since start of pandemic.	We will submit IRB protocol materials in very good shape to promote approval with a single review, and we will submit at least six weeks before we would like to start data collection.	Elaina Sutley
High	Medium	(Theme 2) Timing of data collection corresponds with the implementation of IRA and IIJA, which may cause an anomalous situation in terms of activity and collaborations around resilience (also an opportunity).	Simply keep context in mind during execution of study and interpretation/generalization of results. Look for ways to make this an opportunity.	Elaina Sutley, Bala Natarajan
High	Medium	(Theme 3) Loss of momentum associated with the COVID-19 pandemic that has not been fully recovered.	The deliverables from each task especially system modeling for each infrastructure needs to be streamlined to prevent simultaneous system modeling	Justin Hutchison
High	Medium	(Theme 4) Current economic uncertainties may confound generality in behavioral economic tasks.	Add economic metrics to datasets to serve as covariates (https://kansaseconomy.org/economic-indicators)	Derek Reed
High	Medium	(KDSC) Personnel being recruited away from the project.	Develop common work platform to share resources and create institutional memory, develop contingency plan for loss of personnel.	Tim Pleskac, Lior Shamir, Sergio Salinas Monroy
High	Low	(REU, LSAMP) Increase in operational costs (room and board, travel) for educational programs, such as the REU and LSAMP programs.	Adjust recruitment and number of participants based on costs and budget allotment. For example, the REU program may need to reduce enrollment from 12 students per year to 10 to 11 students.	Jason Bergtold
Medium	High	Despite being part of a larger team, there is often no one with whom to think/talk through concerns/questions related to objective-specific tasks.	Offer team-building exercises; Get regular theme and subtask/working meetings scheduled for the semester to bring team members together; Help organize graduate students into their leadership council and get their meetings scheduled and to include co-working time; Begin tiered mentoring program for faculty.	Belinda Sturm
Medium	High	(Theme 1) Research needs quantitative metrics for otherwise qualitative principles. Doing so could (1) not be possible for all community capitals or all aspects of social equity;	Community engagement provides feedback/input from our study areas on these topics; can use community system-change measurement literature/practices; having different expectations for transferrable versus testbed-specific measures;	Elaina Sutley and Jomella Watson-Thompson

		(2) limit accuracy and fullness of how concept is captured.	develop test-base scenarios of what social equity is/means/how it is measured.	
Medium	High	Resurgence of COVID or another global pandemic that creates widespread shutdowns worldwide.	Lengthen lead times for purchasing supplies, equipment, hiring, etc. Allow significant yet reasonable budget flexibility. Consider virtual connectivity whenever possible.	All ARISE investigators
Medium	High	(Theme 3) Dimensionality increases with complexity. We may not have the resources to implement a fully integrated simulation.	We will start the project with a synthetic system that can be fully integrated. This will help us create necessary additional data to ensure large scale implementation.	Visvakumar Aravinthan
Medium	High	(Theme 3) A majority of infrastructure experts are Assistant Professors, which increases the uncertainty of institutional retention.	Through the first awards and other grant opportunities we should recruit experts who could help us strengthen the infrastructure team.	Visvakumar Aravinthan
Medium	High	(Theme 4) Unexpected interested party disengagement for unforeseen reasons (funding, time or priority conflicts).	Frequent check-ins, ensuring efficiency of engagement requests	Jomella Watson-Thompson, Emily Rountree
Medium	High	(KDSC) Breach of confidentiality. A student or staff member shares confidential data or information from a community partner participating in the Community Data Lab course.	Develop a confidentiality agreement that the Community Partner and the CDL students and staff sign. The agreement establishes with the Community Partner that we strongly recommend Project involve no confidential, classified, proprietary, or similarly restricted information. By participating in this program, the Partner agrees that students, faculty, and staff may freely discuss all information associated with the project as part of the normal educational process. If there is confidential data or information then the partner and the KDSC staff work to establish a plan to handle the data. This includes data storage and sharing, work station, and establishing procedures to keep the confidential data secure.	Tim Pleskac, Will Duncan, Gryffin Eason

Medium	Medium	(Theme 1) A lot of tasks and all themes are dependent on the Theme 1 survey data. Survey data can take a while to clean; it will have limitations; back to back waves creates for a lot of coordination / administrative type of work that can limit time available for analyzing and interpreting the data.	Basic research across themes will progress based on existing knowledge and assumed models (based on literature review) in years 1-3 so that when the first wave of survey data results becomes available, it can be integrated quickly integrated. Results from the following waves will be used to refine the research in subsequent years.	Elaina Sutley and Jason Bergtold
Medium	Medium	(Theme 4) Challenges exist in working with IN-CORE.	IN-CORE demonstrations will begin in Year 1; the need for researchers to work with IN-CORE won't begin until year 3 after ample training and demonstrations have occurred. NCSA has a lot of experience working with university researchers and will be able to guide ARISE team through process and help along the way.	Elaina Sutley
Medium	Medium	(TRIO + Libraries) Student employee turnover and limited availability. Due to limited staff numbers, we rely heavily on student employees, which means that there is some risk that student turnover and availability issues could hinder project tasks.	Have student employees in both Education and Outreach (2 in Education + 2 in Outreach) involved in all aspects of the project (e.g., education programming in the fall, and outreach events in the spring) so there is cross training for tasks and overlap among student schedules to provide flexibility of coverage. Also, faculty, staff, and students on other ARISE project teams could be recruited to assist with programming (e.g., help with events, facilitate an activity).	Teresa MacDonald, Eleanor Gardner, Carolyn Kocken
Medium	Medium	(REU) Difficulty in recruiting qualified candidates for educational programs and classes, as well as obtaining a diverse and inclusive group of individuals.	Reach out and establish connections with other state universities and community colleges, as well as minority serving institutions to market programs and make presentations and talk with students on campus and virtually. Work within our education programs, such as encouraging LSAMP students and those in the data science education programs to consider the REU Program. Establish relationships with diversity, multicultural, minority, underrepresented group and related organizations.	Jason Bergtold, Derek Reed, Visvakumar Aravinthan, Brenee King
Medium	Medium	(EFC) Unknown demand for resiliency table-top exercise workshop.	Develop engaging and impactful marketing. Engage lots of various partners to assist in marketing (local, state, nonprofit, business and industry). Potentially develop incentives or continuing education credit opportunities.	Tonya Bronleewe

Medium	Medium	(KDSC) Community partners may have expectations that exceed students' abilities.	Establish expectations with community partners	Will Duncan & Gryffin Eason
Medium	Medium	(Theme 2) Community fatigue or loss in interest - change in contact personnel in communities.	Work with community outreach team to cultivate relationships. Increase incentives to participate. Clearly communicate significance of their response.	Jomella Watson-Thompson (?)
Medium	Medium	(Theme 3) Quality of data associated with mapping infrastructure systems (inventory data). Records are not kept digitally. Records are highly decentralized.	Models will be adapted to adjust for data gaps, and use of estimated information will be documented. Uncertainties due to use of estimated data will be assessed.	Aravinthan
Medium	Medium	(EFC) Low attendance at resiliency table-top exercise workshops.	Develop engaging and impactful marketing; Engage lots of various partners to assist in marketing (local, state, nonprofit, business and industry); Potentially develop incentives or continuing education credit opportunities.	Tonya Bronleewe
Medium	Medium	(CEnR) How strong are the partnerships? Decentralized?	Document community engagement and partnership activities in the Community Check Box Evaluation System to examine type and intensity of partnerships. Coordinate with management team and theme leaders to identify and support partnerships.	Jomella Watson-Thompson, Emily Rountree, Elaina Sutley
Medium	Low	(TRIO + Libraries) Budget cuts and rising costs. University and/or state-level budget cuts that result in staff reductions would negatively impact this project. Also, inflation and rising costs could impact the costs of materials and supplies. There is moderate risk that such budget cuts or cost increases will occur.	Mitigation plans for a small budget cut that impacts staff would be to seek other available funds to cover the shortfall. Rising costs would be addressed by reducing the number and/or value of the library stipends for kits, and possibly reallocating project funds. However, a major budget cut that resulted in the loss of staff and/or museum closure would necessitate a suspension and reassessment of this project.	Teresa MacDonald, Eleanor Gardner, Carolyn Kocken
Low	High	(TRIO + Libraries) Limited staff with significant workload. The museum only has five staff responsible for education, outreach, exhibits including multiple active informal science education and broader impacts grant projects (MacDonald oversees all these units).	Some flexibility is built into the timeline to account for unexpected issues, we maintain an overall project tracking document with commitments across all grants, and a have task/action item template for managing collaborative projects with multiple elements and responsible parties such as our Mobile Museum program. If necessary, some shifts	Teresa MacDonald, Eleanor Gardner, Carolyn Kocken

		Also, one position is currently vacant with a search planned for early fall 2022. There is the potential for staff to become overwhelmed due to workload, particularly if unexpected elements arise (e.g., infrastructure event, departure of a staff member) which has the potential to impact project tasks.	in timing or format of project elements would be made to meet program commitments.	
Low	High	(TRIO + Libraries) Pandemic. As the COVID-19 pandemic wears on, new variants can continue to evolve. There is moderate risk that another highly virulent variant (or another pandemic altogether) would cause national or global shut-down.	Consider modifications to planned programming and event activities to be offered as virtual and/or hybrid formats, just as we did during height of COVID pandemic.	Teresa MacDonald, Eleanor Gardner, Carolyn Kocken
Low	High	(KDSC) Mishandling of project, project data.	Establish procedures for handling data.	Tim Pleskac, Lior Shamir, Sergio Salinas Monroy, Will Duncan
Low	High	(KDSC) Loss of funding that makes the work unsustainable.	Work to make time lines and goals, begin developing alternative funding sources.	Tim Pleskac, Lior Shamir, Sergio Salinas Monroy, Will Duncan
Low	Medium	(TRIO + Libraries) New staff member. We have a new educator (C. Kocken), who is in the process of learning her new position and will need time to become familiar with museum, university, and grant structures, policies, and processes. There is a small level of risk (errors, procedural slowness) associated with this.	Education and outreach staff work as a close-knit team so Carolyn will be supported by colleagues (Gardner and MacDonald) and receive any necessary training as we embark on Year 1 of the project. In addition, TRIO 6th and 7th grade students typically take a museum program during a summer campus visit and so Carolyn will have the opportunity to connect with TRIO organizers and students in summer 2022, which would include the student cohort for fall and spring ARISE programming in YR2.	Teresa MacDonald, Eleanor Gardner, Carolyn Kocken
Low	Medium	(TRIO + Libraries) TRIO Student recruitment. There is a low risk of difficulty recruiting participants given	Be flexible and adjust format for the youth program if appropriate (with input from TRIO and youth) and	Teresa MacDonald, Eleanor Gardner, Carolyn Kocken

our long-standing relationship with the TRIO talent search program, that the plan was developed with input from the director of the Talent Search program, we were able to successfully recruit students to participate in trial testing for another project, and staff will connect with these students the summer before through museum programming.

consider swapping timing to use family outreach events as recruitment opportunities if necessary

Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis

Strengths

- The Kansas NSF EPSCoR RII Track-1 ARISE project consists of:
  - A motivated team of people coming together to pursue a shared goal;
  - Interdisciplinary perspectives on classical problems;
  - Innovative out of the box solutions;
  - Extensive experience in human subjects research, stochastic modeling, and machine learning;
  - Transdisciplinary approaches;
  - Extensive experience with defining and computing metrics.
- (Themes 1-4) Sustained industry partnerships across the transportation, water, electricity sectors to facilitate data gathering.
- (Themes 1-4) Strong relationships with state regulatory agencies (e.g., KDOT and KDHE).
- (Themes 1-4) Expertise related to inclusion of equity in infrastructure decision-making.
- Theme 3 will implement tools that are familiar with interested parties. This can serve as a bridge to introduce the novel tools in Theme 2.
- (Themes 1-4) Will train the next generation of students as "system thinkers" rather than hyper-focused on one infrastructure or discipline.
- (Theme 4) Methodology experts with sufficient overlapping interests.
- (Theme 4) Preexisting collaborations within KU.
- (Theme 4) Preexisting collaborations with IN-CORE, and the IN-CORE team is positioned to build out outside projects/users like us.
- (CEnR) Strong letters of support and strong basis of community partner support starting the project across diverse sectors – transportation, energy, water.
- (CEnR) Community partners in infrastructure.
- Wide reaching educational, outreach, diversity, and workforce development programs that include multiple facets of community engagement.
- (TRIO + Libraries) Staff expertise in informal STEM education / science outreach.
- (TRIO + Libraries) Experience successfully managing and completing complex, multi-faceted broader impacts projects.
- (TRIO + Libraries) Extensive experience working with researchers across KU and beyond.
- (TRIO + Libraries) Long standing strong relationship with TRIO program partner.
- (TRIO + Libraries) Established relationships with Kansas public libraries, in both urban and rural locales.
- (EFC WSU) Extensive network of local governments and utilities across Kansas.

- (EFC WSU) Experience developing and implementing interactive training and professional development workshops and durable resources.
- (LSAMP/REU) Experience developing and coordinating summer research programs.
- (LSAMP/REU) Established relationships with Hispanic and minority serving institutions.
- (KDSC) We have a diverse team across the state regarding expertise, location, and background.
- (KDSC) We have developed a good foundation of community organizations.
- (KDSC) Most of the core schools that are part of the KDSC have an existing data science program or one in development.
- (KDSC) At KU, KState, Wichita State, Baker, and Donnelly, there are existing courses that we can use or adapt for the Community Data Lab curriculum outlined in the ARISE Strategic Plan.
- (KDSC) Students across the participating institutions have diverse academic backgrounds (e.g., students in WSU's data science MS have undergraduate degrees other than computer science and engineering).
- (KDSC) Project has funding for personnel devoted specifically to KDSC who can help anchor activities and maintain longevity.

Weaknesses
- There are many dependencies, linkages, inputs/outputs from one task to another. (1) Some are known, some are not well understood; (2) a delay in one could cause substantial delay down the road for another.
- Convergence aspect of research directions are new for many participating investigators. While there are experts on relevant disciplines/topics (E.g., community engagement), there are also limitations in interdisciplinary and breadth of knowledge across all/many areas for ARISE researchers. This may slow the process of getting started together.
- Challenges exist in working with new collaborators
- Despite being part of a larger team, there is often no one with whom to think/talk through concerns/questions related to objective-specific tasks
- Disciplinary, subject matter and method knowledge gaps exist, such as SHFGT framework, specific infrastructure knowledge and qualitative research methods, emergency management, and disaster and resilience planning.
- (Theme 1) Research needs quantitative metrics for otherwise qualitative principles. Doing so could (1) not be possible for all community capitals or all aspects of social equity; (2) limit accuracy and fullness of how concept is captured.
- (Theme 1) A lot of tasks and all themes are dependent on the Theme 1 survey data. Survey data can take a while to clean; it will have limitations; back to back waves creates for a lot of coordination / administrative type of work that can limit time available for analyzing and interpreting the data.
- (Theme 3) Data from infrastructure systems have different temporal, spatial and measurement scales, which will need to be integrated for a common analysis platform.
- (Theme 4) Challenges exist in working with IN-CORE

- (CEnR) Disaster management side is potential gap
- (CEnR) How we define and work with community partners as a team – are we on the same page? When do we need commonalities? When are MOUs necessary?
- (CEnR) How strong are the partnerships? Decentralized?
- (TRIO + Libraries) New staff member. We have a new educator (C. Kocken), who is in the process of learning her new position and will need time to become familiar with museum, university, and grant structures, policies, and processes. There is a small level of risk (errors, procedural slowness) associated with this.
- (TRIO + Libraries) There is limited staff with significant workload. The museum only has five staff responsible for education, outreach, exhibits including multiple active informal science education and broader impacts grant projects (MacDonald oversees all these units). Also, one position is currently vacant with a search planned for early fall 2022. There is the potential for staff to become overwhelmed due to workload, particularly if unexpected elements arise (e.g., infrastructure event, departure of a staff member) which has the potential to impact project tasks.
- (TRIO + Libraries) Student employee turnover and limited availability. Due to limited staff numbers, we rely heavily on student employees, which means that there is some risk that student turnover and availability issues could hinder project tasks.
- (REU) Difficulty in recruiting qualified candidates for educational programs and classes, as well as obtaining a diverse and inclusive group of individuals.
- (EFC) Unknown demand for resiliency table-top exercise workshop.
- (KDSC) Diversity in the KDSC is a weakness in that we have to find a common language, procedures, etc to work across the KDSC.
- (KDSC) There are different levels of student experience and expertise across the schools that could impede the functioning of the KDSC.
- (KDSC) Community partners may have expectations that exceed students' abilities causing partners to grow frustrated and withdraw.
- (KDSC) The course has not been taught at all sites.

Opportunities
- To truly change the way researchers and practitioners approach their work – including their collaborations, and how they evaluate priorities and success – in a way that supports equity and the greater good.
- Build research capacity by adding faculty investigators to ARISE via seed funding (First Awards and REI Awards).
- Wider acceptance of video-conferencing platforms, which facilitates more interactions.
- (Theme 1) Emerging federal funding opportunities in interdependent infrastructures.
- (Theme 1) Growing Infrastructure investments in renewables and sustainable solutions.
- (Theme 1) Inter-Agency Agreement (IAA) will streamline IRB approval process.

- (Theme 2) Emerging funding opportunities in community centric resilience.
- (Theme 2) New ideas and research directions may emerge from our engagement with interested parties.
- (Theme 2) Possible consulting services.
- (Theme 3) Develop relationship with state regulatory agency for electricity grid management (PUC).
- (Theme 3) Connecting research and policy with state regulatory agencies and interested parties.
- (Theme 3) Co-simulate infrastructure systems to better understand interdependencies and system risk.
- (Theme 3) Several grant opportunities to pursue additional funding for this line of work.
- (Theme 3) Opportunities for novel collaborations across Kansas research universities.
- (Theme 4) The notion of behavioral economic "nudges" is becoming popular in policy development.
- (Theme 4) Increase in infrastructure stressor may inflate demand for behavioral economic solutions/insight.
- (Theme 4) The integration of proposed tasks and social equity variables is relatively unexplored.
- (CEnR) Cross-disciplinary approach can result in new research projects, connections, and partnerships.
- (CEnR) Stronger connections for infrastructure systems across the state.
- (CEnR) Budget exists for enhancing community-engaged research.
- (TRIO + Libraries) Societal trends – increasing public interest in understanding impacts of climate change and natural hazards.
- (TRIO + Libraries) Potential collaboration with social media influencers within target communities, to help spread the word about family STEM nights and bilingual activity kits.
- (EFC WSU) Informed and active local governments, utilities, and decision makers who plan for disasters proactively and equitably.
- (LSAMP/REU) Presentation of research topics to a diverse group of students.
- (KDSC) We have created a structure to connect universities and colleges to community partners across the state.
- (KDSC) We can create a new path for jobs and internships with students.
- (KDSC) We can extend this framework to graduate and undergraduate training across Kansas universities.
- (KDSC) We can use this framework to reach out to K-12 education.
- (KDSC) Increase research capacity for ARISE in that projects can be spun off from the research arm.
- (KDSC) Positively impact Kansas' economic development by addressing organizations' needs through student project outcomes.
- (KDSC) There are many organizations active in KS and not currently in the consortium working to promote data science and encourage data science skills.
- (KDSC) Possibility for AI patents? E.g. Create hub of data science start-ups in Lawrence – possibility to partner with Brian McClendon's Lawrence tech group or the Douglas County Core (equivalents in other parts of KS).

Threats

- Resurgence of COVID-19 or other global pandemic leading to widespread shutdowns.
- Loss of expertise due to poaching of faculty, and other project personnel to other institutions.
- Inflation - Projects costs will be higher than expected.
- Ability to hire and retain good quality post docs and GRAs.
- IRB offices have been slow to review since start of pandemic.
- (Theme 2) Increasingly low response rates on surveys -- may hinder ability to do reliable network analysis.
- (Theme 2) Community fatigue or loss in interest - change in contact personnel in communities
- (Theme 2) Timing of data collection corresponds with the implementation of IRA and IIJA, which may cause an anomalous situation in terms of activity and collaborations around resilience (also an opportunity).
- (Theme 3) Dimensionality increases with complexity. We may not have the resources to implement a fully integrated simulation.
- (Theme 3) A majority of infrastructure experts are Assistant Professors, which increases the uncertainty of institutional retention.
- (Theme 3) Quality of data associated with mapping infrastructure systems (inventory data). Records are not kept digitally and are highly decentralized.
- (Theme 3) Loss of momentum associated with the COVID-19 pandemic that has not been fully recovered.
- (Theme 4) Current economic uncertainties may confound generality in behavioral economic tasks.
- (Theme 4) Unexpected interested party disengagement for unforeseen reasons (funding, time or priority conflicts).
- (REU, LSAMP) Increase in operational costs (room and board, travel) for educational programs, such as the REU and LSAMP programs.
- (CEnR) How we work with partners and communicate with community partners, both internally and externally – points of contacts and internal management of community partner interactions
- (CEnR) Community-based disaster affecting partners and community members (opportunity?)
- (CEnR) Sustainability threats – continuity of projects, partnerships, educational aspects, etc.
- (TRIO + Libraries) Budget cuts and rising costs. University and/or state-level budget cuts that result in staff reductions would negatively impact this project. Also, inflation and rising costs could impact the costs of materials and supplies. There is moderate risk that such budget cuts or cost increases will occur. (Likelihood – Med; Impact – Low to High)
- (TRIO + Libraries) Pandemic. As the COVID-19 pandemic wears on, new variants can continue to evolve. There is moderate risk that another highly virulent variant (or another pandemic altogether) would cause national or global shut-down. (Likelihood – Low; Impact – High)
- (TRIO + Libraries) TRIO Student recruitment. There is a low risk of difficulty recruiting participants given our long-standing relationship with the TRIO talent search program, that the plan was developed with input from the director of the Talent

Search program, we were able to successfully recruit students to participate in trial testing for another project, and staff will connect with these students the summer before through museum programming. (Likelihood – Low; Impact – Medium).

- (EFC) Low attendance at resiliency table-top exercise workshops
- (KDSC) Breach of confidentiality. A student or staff member shares confidential data or information from a community partner participating in the Community Data Lab course.
- (KDSC) Dispute over intellectual property. During the Community Data Lab students will develop solutions, data, formulae, computer software, products, processes, technologies, etc. Confusion can arise over who owns this intellectual property.
- (KDSC) Personnel being recruited away from the project.
- (KDSC) Mishandling of project, project data.
- (KDSC) Loss of funding that makes the work unsustainable.

Glossary of Abbreviations and Acronyms

Acronym	Definition
ARISE	Adaptive and Resilient Infrastructures driven by Social Equity
CCB	Community Check Box
CDL	Community Data Lab
CE	community engagement
CEA	Community Engagement Advocates
CEnR, CER	Community Engaged Research
CITI	Collaborative Institutional Training Initiative
CS	case study
CSL	Center for Service Learning (at KU)
CSO	combined sewer overflows
DOx	Diversity Objective x
DSS	distribution system simulator
EFC	Environmental Finance Center
EOx	Education Objective x
EPA	Environmental Protection Agency
EPANET	not an acronym, it is an Application for Modeling Drinking Water Distribution Systems developed by the EPA
EPSCoR	Established Program to Stimulate Competitive Research
GNN	graph neural network
GRA	Graduate Research Assistant
HERS	Haskell Environmental Research Studies
HPMS	Highway Performance Monitoring System
HRPP	Human Research Protection Program
HSI	Hispanic Serving Institution
IAA	Inter-Agency Agreement (for IRB)
IIJA	Infrastructure Investment and Jobs Act

IN-CORE	Interconnected Networked Community Resilience Modeling Environment
IPAC	Interested Party Advisory Council
IRA	Inflation Reduction Act
IRB	Institutional Review Board
IUSE	Improving Undergraduate STEM Education
JCCC	Johnson County Community College
KCK	Kansas City, Kansas
KCKCC	Kansas City Kansas Community College
KCMO	Kansas City, Missouri
KDSC	Kansas Data Science Consortium
KNE	Kansas NSF EPSCoR
KS-LSAMP	Kansas Louis Stokes Alliance for Minority Participation
KSU	Kansas State University
KU	University of Kansas
KUNHM	KU Natural History Museum
LA&S	Liberal Arts & Sciences
MSI	minority serving institution
MT	Management Team
NCSA	National Center for Supercomputing Applications
NHTS	National Household Travel Survey Data
NSF	National Science Foundation
PSLG	Post-doc and Student Leadership Group
PSSE, PSS/E	Power System Simulator for Engineering
PUC	Public Utility Commission
QoL	quality of life
QoS	quality of service
REI	Research and Education Innovation (Awards)
REU	Research Experiences for Undergraduate

RFP	Request for Proposals
S&T	Science and Technology
SEAC	Science and Education Advisory Committee
SHFG	stochastic hetero-functional graph
SHFGT	stochastic hetero-functional graph theoretic
SSO	sanitary sewer overflows
STEM	Science, Technology, Engineering, & Math
SWMM	Storm Water Management Model
TRIO	not an acronym, TRIO was given its name after the first three US Dept. of Ed. programs (Upward Bound, Talent Search, Student Support Services) were implemented
TTA	training and technical assistance
WNTR	Water Network Tool for Resilience
WSU	Wichita State University