NSF R2I2
Project Title: Identifying Community Need Based Adaptation and Resilience Priorities in the US Northeast

Technical and Policy (TAP) Meeting 1
Summary and Key Findings

January 23rd, 2026
9:00 am – 11:30 am

Attendees

Nicole Govert	Laura Kerr	Lijing Wang
James O'Donnell	Eleanor Ouimet	Sarah Strauss
John Truscinski	Preston Spicer	Seth Tuler
Joseph Macdougald	Rob Nazarian	Jessica Jansujwicz
Louanne Cooley	Jennifer O'Donnell	Austin Becker
Brett Branco	Zheng Ren	Steven D'Hondt
Jennifer Lauren Ross	Francesco Peri	Zhi Li
Kimberly Huguenard	Jiaze Wang	Emmanouil Anagnostou
Yaprak Onat	Jon Nelson	Matthew Janssen
Mary Buchanan	Jennifer Dineen	Kayla Vargas
Philip Orton	Taylor Louise Bailey	Dan Bader
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Introduction

This report provides a summary of grant themes and a synthesis of discussions from the first NSF R2I2 Technical and Policy (TAP) meeting. The TAP convenes researchers and policy experts to guide development of a competitive "Phase Two" proposal for the NSF R2I2 initiative focused on advancing geoscience-based resilience priorities at the local scale in the Northeast.

Program Context and Phase Two Direction

The R2I2 project is a collaborative research effort designed to identify and prioritize community-driven climate adaptation and resilience needs across the U.S. Northeast. Led by the University of Connecticut in partnership with academic institutions, state agencies, municipalities, and private-sector stakeholders across Connecticut, New York, New Jersey, and Maine, the project centers municipal and regional decision-making as the driver of research direction. Rather than

advancing science in isolation, R2I2 is structured to co-produce knowledge with end users, ensuring that research outputs respond directly to real-world planning, policy, and implementation challenges.

Phase 1 of R2I2 focuses on synthesizing existing knowledge, identifying priority climate adaptation challenges, and establishing interdisciplinary working groups organized around shared research themes. Through these working groups, the project aims to develop a prioritized set of potential solutions, and metrics of success, alongside an assessment of regional education and training needs. This phase also lays the groundwork for sustaining collaboration amongst the research institutions by defining strategies for governance, staffing, and long-term funding. Collectively, these activities position Phase 2 to move beyond problem identification toward projects, tools and strategies that accelerate transformative action across the Northeast. The following is a summary of potential research themes that may become the focus of the Phase Two proposal as they were presented during the TAP meeting.

R2I2 Research Themes – Summary Narrative

Flood Hazard Mapping

Flood Hazard Mapping focuses on developing forward-looking, defensible flood risk information that reflects future climate conditions rather than relying solely on backward-looking FEMA flood maps. In the Northeast, flood risk is increasingly driven by compound flooding processes—interactions among sea level rise, storm surge, rainfall, and riverine flooding—that are not captured by single-hazard mapping approaches. Local-scale features such as roads, culverts, and tide gates further influence flood outcomes, creating meaningful differences in risk at the neighborhood level.

The R2I2 collaboration offers an opportunity for research to link regional and state-scale flood models to actionable, municipal-scale flood products that can support planning, zoning, and capital investment decisions. This includes moving from binary flood zones to graded risk representations and establishing the technical and legal basis for their use. Key challenges include representing compound flooding at high spatial resolution, transparently incorporating future conditions, and ensuring that municipal planners and engineers have the capacity to understand and apply the results.

Technical emphasis: This work will require translating regional hydrodynamic and hydrologic models into neighborhood-scale inundation maps (≈1–2 m resolution) with explicitly quantified uncertainty under future climate scenarios.

Flood Adaptation Modeling & Decision Support

This theme centers on improving flood modeling tools so they directly support adaptation decisions at the project and community scale. Advances in observation technologies, such as

GPS, InSAR, and sensor networks, combined with machine learning, now enable more accurate and probabilistic assessments of flood risk. These tools allow communities to evaluate trade-offs, costs, and benefits of adaptation strategies under both current and future conditions.

The primary challenge lies in translating sophisticated models into consistent, trusted, and usable decision-support tools. Differences in modeling platforms, data inputs, and validation approaches create barriers to standardization and adoption. Collaborators on this R2I2 project have emphasized the need for regional consistency, technical assistance, and sustained observing systems to ensure models remain credible, affordable, and usable by municipalities, insurers, and emergency managers.

Technical emphasis: Modeling will integrate compound drivers (coastal, pluvial, fluvial, subsidence, drainage) within probabilistic frameworks capable of supporting ensemble-based benefit–cost and risk tradeoff analyses.

Flood Prediction & Alerts

The Flood Prediction and Alerts theme focuses on delivering hyper-local, human-scale flood forecasts that reflect the full range of compound flooding drivers. Recent advances allow street-level flood forecasts days in advance, as well as rainfall nowcasting that supports warnings minutes to hours ahead. Ensemble forecasting approaches further enable communication of flood probability rather than relying on single deterministic outcomes.

R2I2 collaborators have highlighted the importance of co-designing forecasts and alert systems with emergency managers and communities to ensure usability and trust. Key challenges include the computational demands of scaling forecasts to dense urban areas, communicating probabilistic information clearly, and navigating legal and institutional responsibilities. Coordination with NOAA and local Weather Forecast Offices is critical to avoid conflicting messages and ensure long-term operational sustainability.

Technical emphasis: Couple high-resolution compound flood models with ensemble meteorological forcing and real-time observations to generate probabilistic, street-scale flood forecasts and alerts.

Coastal Nature-Based Features

The Coastal Nature-Based Features theme addresses the need for science-based guidance on living shorelines and other nature-based solutions that reduce erosion and flood risk while providing ecological and social benefits. While these approaches are increasingly promoted, uncertainty around their long-term performance under changing climate conditions remains a major barrier to design, permitting, and investment.

This R2I2 collaborative seeks to build an evidence base that links local hydrodynamics and sediment dynamics to the performance of nature-based features under both current and future conditions. Priority needs include consistent monitoring, performance metrics, and decision-support tools that enable adaptive management. Translation challenges include integrating new science into regulatory frameworks, accounting for uncertainty, and providing municipalities with training and technical support.

Technical emphasis: Quantify NBF performance across site-specific wave, current, and sediment regimes, nested within larger regional coastal dynamics, to support transferable design guidance.

Wind Hazards & Power Grid Resilience

This theme focuses on strengthening power grid resilience in the face of increasing severe wind events and compound hazards. Climate projections indicate more frequent extreme wind gusts across parts of the Northeast, interacting with aging infrastructure and social vulnerability to increase the likelihood and consequences of power outages.

Collaborators on the R2I2 team have emphasized climate-informed outage risk assessments, resilience metrics, and decision-support tools that explicitly incorporate equity considerations. Actionable pathways include resilience roadmaps aligned with regulatory goals, circuit-level dashboards, and pilot projects such as community microgrids and battery storage. Persistent challenges include quantifying resilience benefits, navigating regulatory approval processes, and engaging communities in grid modernization efforts.

Technical emphasis: Downscaled climate model simulations (e.g., CMIP6) combined with infrastructure and social vulnerability data to probabilistically assess outage risk and resilience gains at the circuit level.

Heat Risk

The Heat Risk theme advances hyper-local assessments of heat exposure to better protect public health in a warming climate. Heat risk varies dramatically within communities due to land cover, building form, vegetation, and social vulnerability, yet existing heat indices often fail to capture the actual street-level exposure experienced by residents.

Under this R2I2 collaborative, research team members have proposed building a street-level evidence base using dense temperature, humidity, and wind sensor networks combined with built environment and activity data. These data can be translated into decision tools that guide equitable investments in cooling centers, urban greening, building codes, and worker protections.

Key challenges include developing defensible and transferable methods, turning maps into clear priorities, and minimizing implementation burdens for municipal staff.

Technical emphasis: In situ microclimate measurements with urban form and land-cover data to model human heat exposure at spatial scales relevant to health outcomes and intervention design.

Policy and Implementation

The Policy and Implementation theme emphasizes that effective climate adaptation depends not only on strong scientific evidence but also on alignment with legal authority, governance structures, institutional capacity, and political constraints. Understanding where authority resides—federal, state, or local—is essential for determining feasible actions. This R2I2 project operates as a regional collaboration focused on state and local decision-making while recognizing that federal frameworks, such as labor and occupational safety regulations, often shape subnational action. Local policy contexts vary widely, from large cities with robust technical capacity to small rural towns with limited resources, requiring scale-sensitive approaches.

Collaborators on this project have framed policy as a pathway for translating research into action. Research can directly shape legislation and regulation, as demonstrated by Connecticut's adoption of scientifically derived sea level rise scenarios as planning benchmarks. Extreme heat provides a clear example of climate policy operating across governance levels. Worker protections under OSHA are evolving at the federal level, influencing proposed state legislation in Connecticut, Massachusetts, and New York. Meanwhile, cities like Boston and New York have enacted guidance or ordinances enhancing worker protections, showing how local governments can act within existing authority ahead of broader mandates.

Discussions on public health–focused heat policy offer insights with the potential to help guide decisions on cooling center placement, land use regulations, and green infrastructure. These discussions also highlight temporal and equity considerations: vegetation-based strategies take decades to yield cooling benefits, while vulnerable residents often need near-term interventions. State incentive programs, like energy efficiency and heat pump financing, demonstrate alignment between adaptation, mitigation, and public health when administrative capacity exists.

Structural barriers also limit implementation. Land- and nature-based strategies require significant land and are intertwined with local land use policy, municipal finance, and governance. Even with strong scientific evidence, municipalities may struggle due to limited staff, reliance on property taxes, or fragmented regional governance. In flood-prone communities, buyouts and large-scale landscape interventions often face economic or political obstacles without changes to funding models, shared services, or inter-municipal coordination. These realities underscore the need for governance innovation alongside technical adaptation strategies.

Greater scientific precision alone does not guarantee policy change. Policy inaction often stems from structural constraints rather than knowledge gaps. This R2I2 team has emphasized the need to produce research that addresses scale, cost, tradeoffs, fiscal impacts, and cumulative benefits, including how regional coordination can create policy "tipping points" unattainable by single municipalities.

Finally, the theme encourages conceptualizing adaptation as an integrated ecological, cultural, and economic system rather than isolated measures. Drawing on traditional ecological knowledge and historical strategies combining protection, accommodation, and retreat, R2I2 seeks policy frameworks that promote long-term stewardship and resilience rather than treating natural systems solely as infrastructure.

Technical emphasis: Policy-relevant research outputs will need to align with legal authority and governance capacity at appropriate scales, considering land use, fiscal constraints, uncertainty, and cross-jurisdictional coordination, identifying opportunities and impediments across state, local, and regional policies.

TAP Meeting 1 Key Findings:

<u>Bridging the Gap Between Science and Local Decision-Making</u>

A central theme of the meeting was the disconnect between existing scientific products and the needs of local decision-makers. Many federal and regional tools are designed at spatial scales that obscure neighborhood-level variability critical for municipal planning, engineering design, and emergency response.

Participants highlighted the need for local-scale thresholds such as flood depths by parcel or roadway segment, precipitation intensities associated with drainage failure, and system performance under compound coastal–fluvial–pluvial conditions.

Current reliance on historical IDF curves derived from long-term stationarity assumptions was identified as a limitation. Participants emphasized that updated, non-stationary IDFs—derived from reanalysis, observational trends, and climate-informed methods—are essential for informing infrastructure design horizons ranging from short-term operations to mid-century planning.

<u>Trust, Standards, and Adoption of Decision-Support Tools</u>

Participants emphasized that model development alone does not lead to impact. Adoption requires demonstrable reliability, transparency, and alignment with legal, engineering, and policy standards.

Key barriers discussed included the absence of shared validation frameworks for flood, heat, and wind models outside FEMA processes; limited guidance on acceptable uncertainty thresholds; and lack of clarity regarding evidentiary standards required for regulatory or legal defensibility. As one participant noted, "It's not that hard to make a new flood model, but how do you prove it's reliable, and what standards of proof are necessary for a lawyer or legislature to act on it?"

Participants highlighted the need for systematic model testing, including hindcasting, stress-testing under extreme and compound scenarios, benchmarking against observations, and clear documentation of uncertainty. For machine-learning-based tools, reliability testing, explainability, and bias assessment were viewed as essential to building practitioner trust.

Communication and Engagement with Diverse Audiences

Effective communication was framed as a technical challenge as well as a social one. Participants emphasized that hazard information must be translated into formats appropriate for policymakers, emergency managers, engineers, and the public, each with different tolerance for uncertainty and levels of technical expertise.

Layered communication approaches were discussed as best practice, combining simplified visual products (e.g., inundation maps or threshold-based alerts) with access to deeper technical documentation.

Participants emphasized that communication strategies must explicitly address equity, accessibility, and trust. This includes accounting for differences in access to digital tools, reliance on non-app-based alerts, and varying levels of familiarity with probabilistic information.

Compound, Seasonal, and Emerging Risks

Discussions repeatedly emphasized that hazards increasingly occur as compound and cascading events. Examples included storm surge coinciding with extreme precipitation, heat waves overlapping with power outages, and winter warming producing ice storms that disrupt energy and communications infrastructure.

Participants highlighted that non-stationarity in precipitation, temperature, and storm characteristics fundamentally alters risk characterization. As one participant noted, "The frequency of compounding events is reshaping risk." Traditional metrics that summarize annual averages or single-hazard probabilities were viewed as insufficient for capturing these dynamics.

Reframing risk as seasonal and compound was viewed as both a scientific and communication opportunity, enabling alignment between technical analysis and how communities experience climate impacts.

Technology Development and Data Integration

Technology discussions encompassed new instrumentation, expanded observational networks, data integration techniques, and standards development. Participants highlighted the value of SAR and InSAR for high-resolution flood inundation mapping and detection of vertical land motion, including subsidence and uplift, which directly affect relative flood risk.

Integrating local sensor networks with regional and national models was identified as a high-priority opportunity. Participants emphasized that meso-scale systems currently lack urban-scale data assimilation, limiting real-time impact tracking. Artificial intelligence and machine learning approaches were viewed as promising for downscaling, pattern recognition, and rapid impact assessment.

However, participants stressed that ML-based tools must undergo rigorous reliability testing, including out-of-sample validation, sensitivity analysis, and transparent documentation, to be credible for operational or policy use.

Policy Capacity, Scale, and Regional Learning

Policy discussions underscored that many municipalities lack the technical capacity to interpret complex hazard analyses or translate them into defensible land use and infrastructure decisions. While states and large cities are advancing innovative policies, smaller communities face structural constraints related to staffing, expertise, and resources.

Participants emphasized the absence of mechanisms for systematic cross-state learning and alignment. One participant observed, "Each state has its own set of innovations, but there is no strong venue for cross-state learning." Regional hubs, leadership networks, and clearinghouses were discussed as potential solutions to support policy diffusion and consistency.

Legal and political sensitivities surrounding land use, insurance, and infrastructure investment were recognized as central constraints that scientific efforts must explicitly account for.

Next Steps:

Working groups will be set up for each grant theme. These may include working groups on: heat and health, nature-based solutions, precipitation, waves, flooding in the Northeast covering rivers, compound flooding and machine learning, workforce education/training, policy, and innovative including carbon sequestration. Concepts from these meetings will be presented to the MAP (Municipal, Agency and Private Sector) stakeholders group.