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TITLE: Building a Learning Network: Reflections from the RISA Program

HIGHLIGHTS:

Sustaining a human network across science and practice can build adaptation capacity

Flexibility, scale & credibility, and widening knowledge underpin network evolution

Social learning framing can strengthen knowledge networks and boundary organizations

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ABSTRACT:

The challenges of applied climate science and decision making require deeper engagement across communities. The RISA program has sustained regional research to advance climate adaptation for 20+ years. Managed to build and sustain relationships through a network, RISA aims to foster capacity necessary for addressing complex climate and social welfare challenges. Reflecting on the design and evolution of the RISA network, we discuss three enduring design characteristics, pointing to examples of contributions to advancing practical climate risk management and adaptation, and relevance for similar networks. We offer our assessment of the utility of social learning as a way to understand the importance of these design characteristics and suggest it as a useful framing for network design and evolution. Challenges remain, but as it matures, we recognize the assets this network has to offer in terms of social learning and transformational change.

1. INTRODUCTION

In the mid1990s, ahead of the first National Climate Assessment [1] and in the wake of new forecasting techniques, NOAA launched an experimental program in regional science and assessment of climate impacts to understand how best to support information needs of on-the-ground managers and policy makers interested in addressing risks associated with a varying and changing climate.

Designing such an investment was at the time a substantial departure from traditional federal science policies [2]. A central tenet of the NOAA Regional Integrated Sciences and Assessment (RISA) Program was and continues to be that *learning* - not just research - is supported and sustained across a wide range of experts, practitioners, and the public with a deliberate connection to evolving decision needs sensitive to climate extremes. The design acknowledged that science alone was among competing factors affecting human welfare and that research benefits should not be expected to be automatic or inevitable. It offered an opportunity for that decision makers to play a role in the creation and diffusion of knowledge, engaging non-scientists to in knowledge production [3,4]. In this way, the RISA program was intentionally designed as a human network**,** prioritizing wide participation in learning by doing, learning through adapting, and reflection on managing risk with uncertain information, even though social learning theory [5,6] was not an explicit framing for program nor used to guide intended or measured outcomes.

In this paper we reflect on this long-standing effort supported by NOAA, looking back on the design and evolution of the RISA program, and we offer our assessment, as network managers and funders, of RISA's enduring design characteristics and their relevance to similar networks aimed at advancing climate risk management and adaptation. We end by considering social learning as both a way to understand why these design characteristics are important and suggest it as a potentially useful framing for the design and evolution of networks like RISA. In offering our reflections, we draw on our own experience as RISA managers, our knowledge of RISA team program evaluation and evolution, and the published literature covering years of RISA's experience connecting science with decision making.

2. Designing RISA as an evolving network

The RISA program began as a set of experimental investments in understanding human and ecological vulnerability to a changing and varying climate. Regionally-based, interdisciplinary teams willing to connect to local stakeholders were funded through five-year, competitive cooperative agreements to develop "problem-focused" research that could inform decision making and through this experience, identify and pursue critical research needs [2,3]. By the early 2000s, RISA teams were cited as examples of boundary organizations that "facilitate stronger knowledge networks among scientists, policy makers...in specific regions by encouraging targeted research to highly focused problems" [7]. The contributions of the RISA

Program to adaptive capacity are noted in science policy literature [8] and by the U.S. Government Accountability Office [9].

Networks and network functions have been lauded as a means for coping with complex challenges, as they enable the wide diffusion of information, continued testing of new methodologies and connection to public and private actors with interests important to public welfare [8,10]. Across multiple fields, networks can build trusted relationships, establish conditions for long-term cooperation and best-practices, and even offer "professional socialization." [11]

With the characteristics of a set of regional teams established, RISA managers, in partnership with the teams, encouraged national scale network qualities, including cross-regional collaboration, common methods for conducting and evaluating activities, and collaboration on problems with national relevance. The RISA community, particularly given its modest proportions, recognized the opportunities and challenges of (and a certain imperative to) orient itself as a "knowledge to action" network [12]. Given the rise in national scale attention to regional and cross-regional threats such as increases in risks of wildfire, water resources disruption, coastal and inland flooding, and extreme heat, there is increased interest in how lessons learned in one context or region might help in another, as well as how current networks function in larger systems [8].

For federal research managers, a network approach inspires a collaborative management model that views regional team leads, mostly from the academic community, as close and interactive partners in network development and management.[1] The factors that drive us toward emphasizing networks and networked systems include the traditionally federal role of regional coordination, the interest in ensuring robust responses to climate risk management by drawing a wider range of views and knowledge into the program, and the lesson learned repeatedly that relationships not only have to inspire iteration, but have to be sustained over many years; "effective knowledge networks should be designed for learning rather than knowing" [7].

Below we discuss three network design characteristics that in our view have endured through the evolution of the program and remain significant to the network today. We attempt to show their potential contribution to advancing climate risk management and adaptation and offer them as considerations for networks with similar goals.

2.1 Importance of flexible management

A purposeful bottom-up program structure and flexible funding model in RISA has supported experimentation and adaptive management within teams and across the network, allowing for iterative reflection [13] over time, innovations in research and engagement, and a nimbleness to meet evolving stakeholder needs.

1 Currently the network is made up of 11 regional teams, see https://cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/RISA/RISA-Teams#739083-risa-teams for more information on geographies covered.

A 5-year time frame allows the teams the flexibility to adjust their course when necessary as decision makers' needs become clearer and/or extreme climate events occur that capture the attention of policy makers, managers and the public. As an example, the Pacific RISA chose to undertake a project, outside of their original plan, to respond to the priorities of the people of Tutuila, American Sāmoa, where islanders were under a ten-year ongoing boil-water advisory for their well water. Pacific RISA assessed recharge timing of aquifers feeding into wells and determined how contaminants could be reaching the well water. "Based on recommendations from the [Pacific RISA] team, the American Sāmoa Power Authority has initiated installation of water filtration infrastructure to resolve the boil water advisory." [14]

Another example demonstrating research and engagement innovation is the climate extension subnetwork that emerged from an initial experiment between the NOAA RISA and Sea Grant national program offices to establish a coastal extension specialist position co-hosted in one region of the U.S. Learning from that initial position in the Carolinas, the national programs subsequently encouraged the infusion of climate extension expertise into RISA and Sea Grant programs more broadly [15]. The current RISA-Sea Grant specialist in Alaska is now working with 29 communities on a visualization tool in response to community concerns about potential fuel spills and increased shipping in the Bering Sea Region [16].

The scholarship of science policy experts within the RISA network also contributes to the capacity of the program to be reflective and innovate on approaches used for stakeholder engagement, co-production and assessment [17,18,19]. The Climate Assessment of the Southwest (CLIMAS), the oldest continuous RISA team, has analyzed years of evaluation findings to demonstrate their evolution over two decades from early multidisciplinary work to transdisciplinary approaches that integrate more fully the traditional and local knowledge of the decision makers with whom they work [20]. Stemming from this process, they re-conceptualize the CLIMAS program as part of a growing regional social learning system, emphasizing "institutional and individual flexibility" [20] and suggest their conceptual model may apply to similar programs, within and outside of RISA.

2.2 Sustained, Credible, Place-based identity

An important tenet of RISA network design is the focus on place-based work. Many stakeholders "[speak] about RISAs as trusted organizations" because of their scientific credibility as academic researchers and long-term presence in the region [21]. A regional purview encourages the sharing of expertise, knowledge and lessons across multiple localities within the region leading to economies of scale, opportunities for transferability, peer-to-peer learning, and collaborations with local offices of federal and state agencies.[2] From our experience, sustained presence in a place, over time, and with a record of success and responsiveness, enhances credibility which creates confidence in the knowledge created and facilitates adaptation practice.

2 National networks with regional, local and state offices include NOAA's National Weather Service field offices, Regional Climate Services Directors, Regional Climate Centers, State Climate Offices, DOI Climate Adaptation Science Centers, and USDA Climate Hubs among others.

RISA experience has shown that a sustained place-based approach is also critical for building practitioner capacity to understand and act on new information [22]. As documented by the Great Lakes RISA team, when municipalities needed strategies to address the effects of extreme events on water treatment plants and electricity transformers, RISA investigators worked in partnership with the Great Lakes and St. Lawrence Cities Initiative (GLSCI) to create a planning tool that organized weather and climate data (rainfall, storm severity, extreme heat) and also laid out a protocol for adaptation actions based on existing implementation capacity. The close working partnership with the municipalities that led to the production of a technical guide also included coordination with state and federal agencies. The tool was piloted in Gary, Indiana, but has now been picked up by Traverse City, Michigan and Evanston, Illinois. Through a partnership with the Urban Sustainability Director's Network (USDN), this particular tool is now being made available to small and medium sized cities in the US and Canada. According to Brenda Henry with the City of Gary, Indiana, the guidebook "helped...secure staff buy-in and build a shared sense of responsibility to be prepared for the next storm." [23]

2.3 Widening the role of knowledge

Of the factors that contribute to adaptation, science is well-recognized as only one of a number of knowledge types that contribute to outcomes [24]. RISAs work to expand sources of knowledge based on place, culture and institutional readiness [25]; a working example of what science policy expert Dave Guston calls, a "collaborative effort of policymakers and scientists [that] can … build better analyses of environmental risks that are relevant for on-the-ground decision makers." [26] By drawing in the participation of professionals with the responsibility to manage risk in the context of operations, regulations or competing interests, the knowledge produced (generally co-produced) has a higher likelihood of influence. Approaches may begin with interviews or workshops with decision makers, but interaction with most is iterative and long-term [27,28].

Research that values diverse knowledge sources, as well as the nurturing of social capital across participants in the research process, leads to important innovations and contributions to the science underpinning climate impacts, risk communication and risk management practices [19,29,30,31]. The Urban Northeast RISA conducted a study of vulnerability to heat-wave related mortality, creating a composite vulnerability index from New York City's mortality and neighborhood data and NOAA meteorological data [32]. Embedding a researcher within the NY City Department of Health (NYCDoH) resulted in co-produced research with NYCDoH that directly served their ongoing efforts and informed the NYC mayoral charge to mitigate the risks of heat waves, known to have among the highest rate of mortality among weather and climate extremes. This resulted in a $106 million program led by the Mayor's Office of Recovery and Resiliency to reduce the exposure of vulnerable populations and enhance public awareness of the risks of extreme heat.[3]

[3] For further information about the Cool Neighborhoods NYC program, see their report: https://www1.nyc.gov/assets/orr/pdf/Cool_Neighborhoods_NYC_Report_FINAL.pdf

Similarly, in response to a season of extreme drought and wildfire in 2016, Carolinas RISA investigators partnered with the South Carolina State Climatologist office (SCSCO) to design the South Carolina Drought Tabletop Exercise. Participants from 40 organizations, including state and federal agencies, the State Emergency Response Team (SERT), reservoir managers, and local water utilities coordinated their drought response options through this simulated exercise, ultimately creating an Emergency Operations Plan [33]. As a result, a drought portal created by the Carolinas RISA and the SCSCO is now relied upon by the State Drought Response Committee (SCDRC) to determine drought indices for all 46 counties in South Carolina; and the Governor's office filled 23 vacancies on the SCDRC [34].

2.4 Reflections on the RISA network approach

The long-term RISA program strategy is to manage RISA teams as a network to foster learning, knowledge sharing and, where resources allow, collaborations across regional teams to answer questions that further adaptation nationally. Our task is to provide a management model able to facilitate learning as RISAs work within and expand beyond their regional networks to connect to mainstream adaptation strategies and further the co-benefits of resilience.

The qualities of the network described above have evolved through RISA's history and have been recognized by other federal entities when launching new networks focused on stakeholder needs and adaptation-related decisions. Nevertheless, there are limitations that should be acknowledged as we aim to strengthen RISA network functions in the future. These limitations include:

1. Leveraging resources inspires collaboration and effectiveness; however, being too highly leveraged requires investigators to meet multiple funders' agendas and can diffuse regional stakeholder-driven research agendas.
2. While reflection is built in, evaluation, especially of societal impact within a broader regional network, is not embedded in all team's structures nor has there been over time a common network-wide evaluative framework.
3. Trade-offs exist in the types of expertise regional teams are able to prioritize, including those critical for reaching a broad range of stakeholders and maintaining effective information flow that supports public awareness, such as communication and extension.
4. University investigators in the network have to balance the academic imperative of advancing scientific knowledge with the more practical considerations of decision making priorities.

3. The RISA Network through the lens of social learning

Social learning offers a useful lens to understand the importance of the core design principles of RISA and their (potential) role in contributing to climate adaptation [35]. Social learning approaches facilitate knowledge sharing, joint learning and the co-creation of knowledge among diverse stakeholders around a common issue, helping to (1) catalyze learning and mobilize change beyond individuals to communities, networks or systems and (2) enable shared

knowledge that leads to changes in practice [36,25]. As a network designed to foster social relationships for improved knowledge generation to support adaptation planning and implementation, RISA employs a variety of participatory processes that enable engagement and participation [27], capacity building and understanding, iterative reflection, and - in a more limited way - begin to challenge institutional norms and practice, all core dimensions of social learning [37]. By managing RISA as a network, rather than a collection of individual projects, collective learning is better enabled and purposefully facilitated by program management at both regional and national levels. Indeed, although the roots are in earth system science, we recognize that the RISA network can be viewed as a long-term 'experiment' in social learning and its resulting impact on regional adaptation within the U.S.

Given the complexities, uncertainties and multiple interests at stake in climate adaptation, success is dependent on learning, especially when focused on collective action [38]. In emphasizing the process of collaboration, rather than one-off products and tools, RISA design has supported more effective knowledge networks [7]. Social learning theory and practice help illuminate the effectiveness of process approaches in catalyzing changes in behavior and practice. Social learning assumes that knowing occurs through action (a process), meaning that process directly influences what constitutes an adaptive behavior and how humans might engage in adaptation. It also offers a way to address complex socio-ecological problems by integrating diverse knowledge and value systems and through iterative learning cycles [36]. Social learning fosters numerous types of learning, including factual, value-based and appreciation of multiple interests or worldviews [39]. The latter, especially as it relates to trust-building, has been important in RISA experience for achieving progress toward changing norms, practice and institutions [31].

Considering this, we suggest that learning may hold the most important value and longest lasting mark of the RISA program. Ultimately, RISA creates a space for situated and collective learning in how to operate and manage under uncertainty; a skill critical to society's success in adaptation [40]. As regional decision-making realities shift, planning and management frameworks and priorities are subject to change, but the capacity developed through the RISA model often endures and continues to be enriched. Examples below explore how social learning dimensions are enabled and advanced in RISA regions, and the value to adaptation that is pursuant.

3.1 Big Wood Basin Alternative Futures Project

The Climate Impacts Research Consortium (CIRC), a RISA team that works across multiple Pacific Northwest states, engaged Idaho water managers in 2012 to discuss their priorities for understanding climate impacts [41]. Water managers identified planning for a future with less water as an important issue given the geography (semi-arid region), water rights allocations, and cross-cutting and complex nature of the issue, which required diverse expertise and experience to adequately address [42]. The Big Wood River Basin in Idaho was suggested as a good site for CIRC to build a collaborative planning network (referred to as a Knowledge to Action Network (KTAN) [43]) and for piloting participatory modeling techniques to test

transferability [41]. The Basin exemplified many of the challenges faced by other Idaho communities around competing trade-offs in water use; however tensions were not likely to preclude broad participation.[4] CIRC led a process in which participants engaged in small group meetings, webinars and three modeling efforts over multiple years. These engagements resulted in numerous collective learning opportunities. CIRC-led modeling efforts included a conceptual model to create shared understanding of the Basin's complex socio-ecological system, build rapport, and an understanding of others' perspectives in the group; and two quantitative models. A systems dynamic model was constructed to consider basin-wide water supply and demand and incorporate local knowledge and preferences into model-building. Upon reflection of results with the participants, the model was determined too simplistic to address the KTAN's questions and a second model was built[5] better able to handle multiple models and policy preferences [44]. As a result, participants had alternative scenarios for collective basin management that considered climate impacts among other drivers, and through participation in the KTAN had developed sufficient understanding and confidence to compare and assess them. Following this effort, some basin farmers who participated in the KTAN have begun experimenting with water-saving techniques as an adaptation strategy.

3.2 Piloting Utility Modeling Applications (PUMA)

The Water Utility Climate Alliance (WUCA), is a coalition of ten of the largest U.S. water utilities to understand the effects of climate change on water supplies and infrastructure. In 2010, four WUCA member utilities, three of whom worked directly with regional RISA teams, and scientific collaborators began the PUMA project, leveraging the expertise of the respective groups to identify climate modeling tools and techniques for impact assessments and improve climate modeling and projection data usability [45]. WUCA approached RISA teams for this project because individual members had already been collaborating with the teams in their regions and thus knew their expertise and ability to work collaboratively. PUMA also aimed to improve collaboration across RISA and WUCA networks, collective learning on co-production practice and generate usable science. This included leveraging the collective expertise on climate modeling across RISA teams. Points of reflective iteration were built into the process through regular meetings with utility and science partners. The real experiment was to see how bringing together knowledge sources (climate modeling projections and utility management tools and experience) could change practice by addressing utility planning needs. The effort led to contextually distinct co-production processes; however, their parallel nature allowed identification of a few transcending qualities. One, some of the most successful, albeit unanticipated, assessment techniques were co-created when science and utility partners collaborated to meet the specific needs of a utility [43]. While all utilities engaged in a similar modeling process, each began their project by jointly identifying questions with their scientific

[4] Participants included university extension, agricultural producers, water managers (both private and public), conservation organizations, landowners, recreational user groups, consultants and government representatives.

[5] This model was based on a software program called Envision developed by researchers from Oregon State University. Envision can bring together multiple models, including existing models, incorporate local data into models and allow exploration of multiple scenarios

partners, tailoring projects toward the utilities' needs and building shared understanding of each drinking water system. For example, in response to the concern by two utilities that precipitation events were poorly represented in existing climate projection tools, new tools were co-created. Two, the role of knowledge networks in the development of institutional capacity and in-house technical expertise was important. The knowledge networks supported actionable science and furthered the internal capacity at the utilities. As one example of evolving practice in utility decision-making, the Seattle Public Utilities adopted a six-year strategic plan within which climate change was prominently featured [45]. Moreover, in a July 6, 2017 letter to Congress, WUCA, the Association of Metropolitan Water Agencies (AMWA), and the American Water Works Association (AWWA) wrote the following about their need for RISA work to continue: "WUCA, AMWA, and AWWA represent some of the largest water providers in the United States, and our organizations provide leadership in assessing and adapting to the potential effects of climate variability and change through collaborative action. RISA program research is vital to our members, who work to protect the nation's water supplies and plan, develop, and deliver high-quality drinking water."

4. Concluding Thoughts

In this paper we have reflected on three of the enduring (and in our view important) characteristics of the RISA model and briefly considered the alignment of lessons from social learning theory and practice to our current network approach. As we consider the potential of this network to address regionally-driven socio-environmental issues, with broad significance to society and human welfare, we recognize that social learning, in addition to the knowledge created, has the greatest lasting value.

Looking forward, we contemplate what a RISA network, and other similar networks, could do to align more purposefully with the lessons of social learning to help accelerate the knowledge, and more importantly the capacity, needed to advance climate adaptation across the nation. Our interest is shifting to focus both on the plans or decisions our efforts may have influenced, and whether the effort is helping to lay the groundwork for transformational change in the long-term. Some of the challenges and trade-offs that regionally-based networks face include:

1. How can networks realize broader impact across the nation, including contributing to national-level adaptation questions, while maintaining the value of the local/regional scale, where adaptation is most readily advanced?
2. How is an appropriate influx of new ideas and expertise maintained in established regional teams without disrupting progress toward team cohesion and stakeholder engagement?
3. How are regional teams incentivized to collaborate with each other across regions as they simultaneously strive to meet growing demands within regions (given limitations on capacity and resources)?

The experience of working in partnerships across this network has taught us the importance of prioritizing investment in long-standing human capacity. Given advancements since the inception of RISA in the science underpinning global environmental change, in which we include

social systems, we feel there is a need to more seriously consider how social and economic welfare outcomes tied to climate adaptation become more prominent as indicators of network success. Finally, we look forward to building, with our partners, stronger mechanisms to enhance learning and capacities by connecting cohorts of peers, testing transferability across communities with embedded similarities, and stimulating interactions that further the rich interpersonal relationships, learning and social narratives already fostered within subsets of the network.

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