CHAPTER 1

Assessing needs and decision contexts: RISA approaches to engagement research

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1.1 Introduction

Research on how mankind will adapt to climate variability and change are undeniably important, and yet, traditionally, society tends to turn mainly to physical science for gaining expertise on climate. The Regional Integrated Sciences and Assessments (RISA) program has attempted to remedy this situation by assimilating and generating knowledge that supports the usability of the physical sciences by expanding social and behavioral science on climate and society. We simply cannot understand how best to adapt to climate without gaining knowledge about behavior, policy, institutions, and decision contexts because these aspects often affect the ability of society to respond to and incorporate climate knowledge. Climate research is not only a study of physical processes and impacts, but also a study of individuals, communities, and institutions.

From the beginning, the RISA program has included a human dimensions research element. The number of social scientists in the RISA teams has grown significantly over the course of the program as NOAA staff overseeing

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the RISA program made deliberate decisions over the years to ensure that social science research was funded over the long term and in a continuous manner. This support allowed the RISA teams to undertake the kind of work discussed in this chapter.

The focus of social science research and the methods used vary from team to team and have evolved and expanded over the 20-year history of the program. In the early days of RISA, understanding the context of decision-makers coping with climate challenges focused mostly on assessing user needs, understanding social and institutional constraints in the use of climate information, and the economic value of forecast information. The network of researchers and range of approaches then grew to incorporate the analysis of risk perception and how decision-makers dealt with uncertain information, assessing the vulnerabilities of different socioeconomic groups to climate, and research on ways to communicate climate information. Over the past decade, the National Research Council (NRC) of the U.S. National Academy of Sciences has called on the federal government to increase its efforts in human dimensions research, build a larger community of researchers focused on these issues as they relate to climate, and use these efforts to build stronger national assessments of climate impacts and adaptation [1].

More recently, RISA work has expanded to include identifying and analyzing information flows across networks of scientists and decision-makers and figuring out how to support these networks by working with key individuals or nodes and providing usable information to them (see Chapter 4). Moreover, as the number of published findings from empirical social science research increased, comparative and meta-analysis studies have emerged. These analyses focus on explaining why users disseminate knowledge across RISAs [2] and how different decision contexts shape what RISAs do across regions to meet different users' needs [3].

Most discussions on the RISA approach tend to highlight the iterative nature of how the researchers interact with decision-makers rather than the methodologies involved (e.g., [4]). To understand the decision context of the planners, managers, and communities with which the teams interact, RISAs draw from a range of social science methods and do so in an interdisciplinary and social–physical science setting.

In this chapter, we discuss the approaches used by four RISA teams to understand the context within which decision-makers operate and use information. Some of the approaches are formal and are based on social science research methods, such as survey and network analysis, and others are more informal based on long-term engagement with stakeholders as well as being present at decision-maker meetings. RISAs learn a great deal about context

from both the formal and informal methods. In this chapter, we use the term "decision-makers" to refer to those in the public and private sectors making management and planning decisions. For us, the term "stakeholders" is a broader one that includes other information providers as well as decision-makers and the public.

The four teams from which this chapter's lessons are drawn include Carolinas Integrated Sciences and Assessments (CISA), Great Lakes Integrated Sciences and Assessments (GLISA), Southern Climate Impacts Planning Program (SCIPP), and Western Water Assessment (WWA). Where appropriate, we have drawn examples from other RISA teams as well. The chapter is not meant to encompass all of the social science work undertaken by RISAs, but instead provide some thoughtful insight into the approaches used to understand the context as drawn from the experience of 4 of the 11 RISA teams as well as from a manager of the full RISA program who has observed the breadth and depth of the approaches taken over the years.

1.2 RISA overall approach to ongoing engagement

RISAs are designed to produce new knowledge through fundamental research and to increase the usability of existing knowledge through collaboration with decision-makers and climate information providers. The RISA teams have long and diverse experience with stakeholder engagement of many kinds [5]. RISA researchers regularly and extensively participate in meetings with decision-makers and listen to their concerns, promoting a two-way learning and trust for the knowledge they produce. They also formally study some cases of stakeholder interactions to understand and build a theory on its role in increasing climate information usability.

As Dilling and Lemos [6] observe, iterative engagement between producers and users does not happen in a vacuum and getting it started may take an organization that is willing to foster, and often create from scratch, the conditions necessary to produce usable knowledge. Many decision-making entities produce as well as use knowledge, as do academic researchers thus adding complexity to the analysis of the flow of knowledge or information. Collectively, RISAs have been willing to address this complexity by catalyzing interaction through both formal and informal channels among researchers, decision-makers, and stakeholders.

Coproduction, where new knowledge and the application of that knowledge are produced as a joint venture between scientists and decision-makers, often benefits from interdisciplinary research that draws from the natural, physical, and social sciences as well as interactions within and across

research teams. For RISA teams, methods applied to understanding the decision context are often part of, or at least precede, a coproduction process. For example, when severe droughts began to grip the U.S. southern plains in the fall of 2010, SCIPP was able to build on its understanding of the region's drought planning context, and the team quickly identified the need for improving communication with decision-makers about local drought conditions and the strategies that could be employed to manage drought impacts across the region (see Chapter 9). SCIPP collaborated with the National Integrated Drought Information System (NIDIS), a NOAA Regional Climate Services Director, as well as local agencies and organizations to launch a series of webinars, in-person forums, and a state-planning workshop to improve drought impact reporting and to address these needs. Informal surveys of participating decision-makers were conducted throughout the webinar series to provide feedback on content as well as input on future topics most salient to decision-makers concerned about drought.

Many of the informal methodologies focus on maintaining and building relationships and supporting ongoing dialogue about climate-related issues. We think of these as informal methods because, while there is design to the engagement, it focuses mainly on the process rather than on the scientific outcome (e.g., publishable observations or systematic data collection). Instead, it builds the foundation for further partnerships by helping a RISA team gain insight into decision-makers' working context, improve the "information broker" skills of team members [6], and build knowledge networks. Many of these informal approaches resemble participant observation techniques, such as attending annual meetings organized by decision-maker groups and other partners, connecting with decision-makers during breaks, presenting posters at regional and sectoral conferences, supporting community educational events, and serving on various regional committees. Through these various channels, RISAs are listening and noting the issues that concern decision-makers and can offer insights from climate-related sciences to these communities.

RISA teams also bring people together in workshops, meetings, and conference calls, and all teams have regional decision-makers serving on their advisory committees. More recently, there has been an effort to formalize these approaches into quasi-experimental methods without sacrificing their main goal, which was, increasing climate information use in practice. For example, rather than organizing stakeholders directly, GLISA has created an external regional competition for funding boundary organizations—organizations that already bring scientific information to a set of decision-makers. As a result, these local organizations help to bridge clients' needs with GLISA climate information producers. In doing so, GLISA

has created boundary organization chains that leverage resources (e.g., financial and human) and spread transaction costs (e.g., trust building and legitimacy). To date, GLISA has funded five of those boundary organizations (and started funding five new ones in 2014) that have agreed to document their interaction and collect baseline and comparable observation data with stakeholders for the duration of their project. While the main goal is to engage stakeholders, the project's comparative design will likely generate valuable data to understand opportunities and strategies to increase information usability [7].

Within their social science focus, RISAs employ formal social science methodologies such as surveys, interviews, and social network analysis for specific research purposes and projects. As the social science capacity within the RISA program has expanded, the range of questions and techniques employed has also grown. These formal methodologies are generally selected to complement the informal efforts described above and vice versa. For example, as GLISA was beginning its engagement in the Great Lakes area, they conducted an analysis of documents produced by stakeholders about their needs, rather than conduct formal surveys or interviews that could contribute to potential stakeholder burnout among potential partners [8].

1.3 Key research questions for understanding context

More than two decades of research and experience demonstrate that usable climate information demands that the process used to create the information must not only be scientifically rigorous but must be acutely aware of the context in which information might be used (see [6] for a recent summary). Research questions related to understanding the context of decision-makers are best posed at the beginning of a RISA endeavor (e.g., the launching of a new RISA or the start of a new project) so that the team enters the process with an understanding of the challenges and opportunities the decision-makers encounter. Moreover, involving decision-makers in the initial framing of those research questions is valuable especially as the team efforts get underway.

Although each RISA investigator and/or team comes up with their own set of questions for understanding the decision-makers' challenges, the questions in Box 1.1 are an illustration of the kinds of questions that can lead to a better understanding of that context. There is usually a large amount of upfront work that needs to be done (see Q1 and Q2 in Box 1.1) before directly asking decision-makers about their needs (see Q4 in Box 1.1).

Box 1.1 Types of questions applied to understanding context.

Q1. What is the existing decision-making context with respect to climate?
   a. What decisions are climate sensitive? How sensitive?
   b. What are the time frames in which climate-sensitive decisions are made?
   After this suite of questions, there is often a decision point as to whether to ask directly about needs (Q4) or to ask about the constraints to using climate or scientific information more broadly (Q2 and Q3). The answer depends on the decision-makers and their context.

Q2. What are the contextual factors that influence decision-making and use of climate information? For example, how do the political, social, and economic environments in which people operate affect their willingness to use climate information?

Q3. What are the intrinsic factors that influence decision-making and the use of climate information? For instance, is climate information accessible and available at appropriate temporal and spatial scales? Do decision-makers consider the information credible, legitimate, and salient?

Q4. What are the specific climate information needs of decision-makers (e.g., resource managers, planners, and communities)?

1.3.1 Analyzing the existing decision making context

As a first step to understanding context, by reviewing the literature, researchers might be able to identify broad categories of sectors, such as agriculture, water resources, and emergency planning, where decisions are climate sensitive. Some initial research drawing from primary and secondary data to look at the major industries, sources of economic activity, unique regional attributes, or populations that are directly affected by shifts in climate can help to narrow down these early suppositions. Being aware of the cultural, social, and political values of key organizations that are climate sensitive is important, but their norms and values can be embedded in decision-making and often become more apparent as trust is built. Thus, a more deep contextual knowledge can emerge over time and with ongoing relationships.

In some cases, decision-makers may initially be seeking assistance in understanding their sector's climate sensitivities. Furthermore, some climate-sensitive sectors may view climate as only a second- or third-order issue because of other economic or social forces in play. SCIPP found this to be the case for agriculture during a survey of needs in Oklahoma; agricultural production is highly sensitive to climate, yet producer profits are tied to financial investments where climate plays a lesser role. Researchers who are not experienced with bringing climate into discussions of decision-making and policy may find it particularly challenging to get involved in these multidimensional discussions.

Another critical step in understanding the decision-maker context is to analyze the time frames in which climate-sensitive decisions are made. For example, some decisions are operational, some occur as part of planning processes, and some are part of making long-term projections. In water management, for example, key decisions such as the release of water from dams are made only at certain times of the year, and to be relevant, information must be available at the appropriate time [9] (see Chapter 2). Decisions to improve or build infrastructure, such as reservoirs or groundwater distribution systems, have long-term implications and must consider climate patterns and their potential shifts over decades into the future. Another example is the importance of the seasonal time frame to the energy sector. Seasonal planning is important to the energy sector, especially during the fall in Oklahoma, because decisions must be made about whether to stock up on extra power poles and wires to improve recovery efforts after devastating ice storms [10]. Further, forest managers in the Carolinas make a range of climate-sensitive decisions at many different time frames. They use hourly forecasts to monitor wildfire conditions, seasonal and annual outlooks to schedule prescribed burns, and long-term datasets when managing timber resources and conservation areas. Managers are beginning to consider how future changes in temperature, precipitation, and the prevalence of extreme events, might impact species selection, hardiness criteria, and biological threats such as invasive species [11]. Developing a sense of the key decisions and associated time frames within an organization is essential.

Understanding the decision context also requires knowing where and how organizations or individuals might already be using climate information. Using methods similar to those discussed above, social science researchers develop specific protocols to learn where decision-makers currently obtain information from, why they use and trust it, and how it helps them accomplish their mission. While new information does not necessarily need to share the same attributes, it is helpful to know about any prior experiences (either positive or negative) using climate information and how those experiences might affect any future attempts to provide usable climate information to those decision-makers.

RISA researchers use multiple methods to assess the decision-making context with respect to climate, including participant observation, interviews, questionnaires, focus groups, and review of the operational documents of organizations. Written documents such as policies, plans, and minutes of council meetings are helpful for gaining a background understanding of an organization's decision context. Stakeholder-institutional analysis is another approach to uncover the broader decision-making context. It involves identifying and examining who makes decisions, the

roles and responsibilities of different stakeholders, the rules and organizational arrangements that guide or structure management decisions, what information or knowledge is used, and how risks and uncertainties are perceived and managed. For example, GLISA's "Assessing Assessments" project built a comprehensive database of stakeholder characteristics and needs in the region and identified engaged stakeholders and information about the organizations they belong to (characterized by scale, sector).

RISA researchers work directly with decision-makers such as water utility managers, city planners, or farmers. Meeting directly with decision-makers through a combination of dedicated workshops and interviews, and observations of the decision-makers in their working environment can give the researchers in-depth information about the decision context. In order to develop the Dynamic Drought Index Tool (DDIT) (see Chapter 8) and other drought information and mapping tools, CISA researchers initially worked with decision-makers to understand the drought management context. Methods included formal meetings with state drought response committees and document analysis (i.e., assessing state level response plans and the Federal Energy Regulatory Commission (FERC) licenses that regulate water availability in many of the basins in the Carolinas). Much of the progress the WWA has made in understanding the regional context for water-related decision-making has come through the use of iterative processes that have built an understanding between researchers and decision-makers over several years [12].

Toward this aim, all RISAs have at least one full-time, year-round program manager focusing on the team's overall interactions with decision-makers, and many RISA researchers work with intermediaries (e.g., extension services, NGOs, and other boundary organizations) between the research community and the decision-making communities (see Chapter 4; see also [7]).

1.3.2 Analyzing factors that affect climate-sensitive decisions, including the use of climate information

Understanding both the contextual and intrinsic factors that affect the use of climate information is an important step in producing salient and effective decision support for decision-makers [6].

1.3.2.1 Contextual factors

Developing usable information requires that researchers are aware of and consider how decision-makers operate within a particular regional context, pursue different organizational goals and objectives, and face a variety of

political, social, and legal pressures [4,13]. Contextual factors include the organizational and institutional structures that shape decision-making as well as the social, cultural, political, economic, and physical processes that affect the vulnerability of sectors or communities to climate. In addition to understanding the decision process itself, research projects should also take stock of the broader suite of factors that might be increasing or decreasing the sensitivity of the region to climate or the ability of decision-makers in the region to use climate information.

1.3.2.1.1 Organizational and institutional constraints and opportunities:

The options or flexibility that a community or sector faces in dealing with their climate-sensitive decisions can greatly impact their interest in engaging climate information. If the options are limited or severely prescribed, it will be much more difficult for managers to use new information no matter how accurate and credible they are. For example, in many regions, water management decision-making is often legally prescribed, and managers must follow very specific rules in making decisions about water allocation and use. These rules may limit water suppliers in adapting decision processes to incorporate new information. In some cases, only designated types of information can be used (e.g., rule curves that regulate reservoir operations). Nonetheless, there are also many examples of creative and collaborative processes that have been formed to develop legal, robust solutions to new information about climate risk, such as water banking and informal water trading.

Often, the decision space, or "the range of realistic options that can be used to resolve a particular problem," [14, p. 9] varies by management level and spatial scale. For example, a group of "water managers" may include municipal officials, federal agency managers, and state government water departments—all of whom operate in different decision spaces and contexts [13]. Each decision-maker has only a limited area of responsibility and authority to make decisions as well. In research projects, it is critical to understand what role the person participating in the study plays in the decision process and what authority they have to make decisions in order to place their information in the appropriate context.

1.3.2.1.2 Political, social, and economic constraints and opportunities:

Some of the contextual factors that affect the use of information come from outside of the organization itself and include political considerations, different levels of risk tolerance, and costs of available options. Many RISAs have found that engaging in dialogue on climate variability and extremes can be

a useful entry point for working with stakeholders that might otherwise be unreceptive to discussing climate change. In some cases, extreme events can help catalyze stronger relationships between stakeholders and researchers as stakeholders seek to cope with responding to or planning for a future event. For example, the drought of 2002 in the WWA region provided a tremendous window of opportunity to open a dialogue about the role of climate variability on water supplies; this type of dialogue was not as pervasive or perhaps even acceptable prior to that point. Interest in regional institutions providing climate information grew after that precipitating event and expanded to an interest in the area of climate change impacts on local water supplies [12].

Political constraints can affect communication and messaging as well. When SCIPP speaks about climate change they focus on climate variability because extremes often occur in the region and have a tremendous impact on communities. In some cases, discussing climate change can carry real risks from a professional standpoint for some resource managers; therefore, sensitivity to those risks is warranted. Likewise, the political environment in the Carolinas, particularly on the state level, is unsupportive of climate change science and initiatives to adapt to climate change. Where adaptation activities are occurring, they are frequently mainstreamed into other types of activities and/or are framed or communicated in alternate terms. CISA research and engagement efforts are sensitive to framing and take into account these constraints on decision-makers [15].

The social and economic tolerance for risks can also differ regionally and affect the willingness of decision-makers to incorporate new information into decision-making and identifying new options. How decision-makers perceive risks and address uncertainties should also be considered and incorporated into decision-support systems. RISA researchers working with agricultural decision-makers and agricultural extension agents may need to consider not only regional and local conditions, but also how international competition and management regimes affect supply and demand. Researchers working with Native American groups will need to understand the historical context and legal frameworks in which these communities make decisions.

As might be surmised from the above discussion, the ability to understand and navigate the contextual factors that affect the ability of an individual or organization to use climate information must be developed through years of interacting, maintaining relationships, and building trust. What makes RISA work unique is the commitment of researchers to develop sustained interactions and in-depth, long-term relationships with stakeholders. Ongoing engagement between scientists and decision-makers contributes to mutual learning and appreciation for each other's needs and constraints, trust building, and the building of networks through which information can be shared.

Such interactions can also help to facilitate efforts to improve understanding of how to manage uncertainties and risks [14,16]. Lemos and Morehouse [4] use the term "iterativity" to describe the process of ongoing interaction between scientists and decision-makers in the Climate Assessment for the Southwest (CLIMAS). Such processes allow researchers and stakeholders to work together to develop tools and information, test those tools, and share feedback for future improvements [14]. In the Carolinas, for example, Carbone *et al*. [17] gathered information through formal and informal interactions, over several years, with water resources stakeholders to identify needs for drought information, as well as to understand the institutional context in which drought response and management decisions are made.

Lowrey *et al*. [12] also discuss the value of long-term, ongoing interactions between decision-makers and scientists within the WWA. The ability of researchers to know the regional context and draw from multiple methods to collect and synthesize information was crucial in guiding their work with Colorado water managers. In addition, informal meetings and interactions are other means through which RISAs can share information, foster social capital, and build capacity for follow-up activities with decision-makers [18]. CISA researchers frequently use such opportunities to keep current on the stresses, as well as opportunities, that influence decision making at multiple levels.

1.3.2.2 Intrinsic factors

In addition to the contextual factors that affect the use of climate information there are several factors affecting use that are more directly related to the information itself and the way it is produced. Decision-makers often have responsibilities for a given geographic region, population center or particular resource. One of the most frequently heard complaints about climate information, for example, is its lack of regional specificity and the lack of skill in the information that is downscaled from climate models. The DDIT for the Carolinas (see Chapter 8) was developed in response to decision-makers who requested drought information at a variety of temporal and spatial scales.

Accessibility of information is also an important component of use. It means that information is readily available and that users can obtain the information from sources such as online databases or personal contacts. Accessibility also means that information is communicated in a way that is understandable. For example, reports that are written in a nontechnical manner, avoid use of scientific jargon, or provide summary information for decision-makers are more accessible.

RISAs work to improve accessibility by improving our understanding of and developing effective methods for communicating climate information.

They apply communications research and "best practice" strategies in their role as information brokers (in preparing newsletters, outlooks, webinars, conferences, etc. for decision-makers). In some instances, RISA investigators have conducted formal research projects to develop and assess these strategies. For example, CISA researchers have used focus groups and web-based surveys from drought and water managers to obtain feedback on graphical representations of probabilistic information and seasonal climate forecasts [19] as well as to assess effective methods for visualizing drought information [20]. The CLIMAS RISA has used newsletters and synthesis reports as boundary objects to inform stakeholders [21].

1.3.2.3 Identifying climate information needs

All too often, the results of scientific research do not inform decisions made by practitioners, despite the intention to produce usable information. We do have evidence, however, that when we understand users' needs we produce more usable science [22]. Thus, understanding the specific climate information needs of different decision-makers is a vital step in providing society with relevant and useful products and services. This step is often left out of the scientific process, which can lead to information that is not useful to or usable by the audience for which it is intended. RISA teams are fully aware of this problem and recognize the importance of understanding what, when, where, and why climate information is needed in particular decision contexts.

Understanding climate information needs drives the development of RISA products and services such as, but not limited to, online climate tools, educational brochures, in-depth reports, and webinars. For instance, in the beginning stages of SCIPP, its team assessed climate information needs through an online survey that was distributed in 2009 to hazard planners across its six-state region [23]. The survey was distributed again in the spring of 2013 to understand what changes occurred since SCIPP was established in 2008. The assessment focused on hazard planning activities across the region and included some questions about information needs. The regional sampling provided a broad representation of the needs of SCIPP's stakeholders and reached decision-makers at various types of agencies and organizations (governmental and nongovernmental) and at various levels (local, state, tribal, federal, etc.). The results then guided SCIPP's research, products, and service efforts.

In contrast, further along in SCIPP's development in 2010–2011, researchers used semistructured interviews to assess climate-related needs in Oklahoma [10] and along the Gulf Coast [24], which are subsets of the SCIPP region. During this stage of SCIPP's evolution as a RISA, the team chose to go more in-depth in order to understand the individual

and agency-specific needs, to build relationships that are important for an evolving RISA, and to contribute detailed information about needs to inform the federally-led U.S. National Climate Assessment.

Needs are often complex and may require some conversation. Furthermore, in-person interviews provide the decision-maker the opportunity to begin building a relationship with the interviewer (the information provider or liaison in many cases), which may be vital for decision-makers to feel they have a stake in the issue. In some instances, a need may be identified in an interview that can be met with existing resources. For example, an engineer who participated in the Oklahoma needs assessment asked about historical precipitation data during his interview and a water resource official was interested in soil moisture data. In both cases, the interviewer was able to provide the decision-makers with the data shortly after the meeting.

Workshops are another useful means for determining climate information needs. While the dialogue is typically not as in-depth or specific as during a one-on-one interview, a group discussion can generate ideas that may not otherwise surface. SCIPP employed this method in 2011 when they helped facilitate a workshop with Oklahoma tribal representatives [25]. A workshop setting also fosters relationship building that is often an important component to meeting climate-related needs.

Similarly, WWA has engaged in multiple means of ascertaining user needs, including interviews, workshops, document review, and other informal meetings [12,26]. In some cases, the needs of stakeholders in the context of climate information was not apparent to them until they gained a basic understanding of climate and how it affected the resources they were managing. For example, after a significant drought event, interest at the state level, and the mobilization of new capacity to engage regional stakeholders on preparing for drought (i.e., the formation of NIDIS), WWA held a series of workshops around the state of Colorado called "Dealing with Drought." Participants ranged from water providers and managers, tribes, community leaders, environmental conservation groups, academics, and federal lands managers. The goals included both sharing knowledge on drought and climate variability and change, as well as hearing from stakeholders as to what their concerns were [27]. As a result of the workshops, many stakeholders expressed that they did not feel they had sufficient information about how drought affected the resources they managed. WWA also learned that the stakeholders in the region did not feel sufficiently aware of the informational resources that were available, and that they did not know how to use the information that was available. These workshops were invaluable not only for sharing valuable information with stakeholders, but also for making WWA aware of the needs that were still unmet in the region.

In addition, researchers choose methods to get people to think about their needs and to sensitize them to or develop their thinking about climate and climate information. For instance, some approaches involve, as part of the participatory process, exposing participants to information that may be useful to them. This expands the participants' understanding of their specific needs within the context of science that is currently available as well as could be possibly available in the near term. RISAs frequently generate products that are used and interpreted differently by different groups. Such "boundary objects" can assist both researchers and decision-makers in identifying and developing shared understanding [22,28]. Examples of boundary objects include GIS tools and interactive maps, syntheses reports, climate scenarios, and planning documents. For example, CISA helped to develop the Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) process as a tool to facilitate dialogue and information sharing between scientists and decision-makers, as well as between decision-makers within a community. This process helps local decision-makers identify climate impacts and needs in their communities and identify and develop response and planning strategies to meet those needs.

1.4 New and evolving area of RISA research: analyzing knowledge networks

In the past few years, scholars focusing on the ability of different systems to respond to climate change impacts have increasingly highlighted the role of knowledge networks as both harbingers of positive normative characteristics (they build trust, amalgamate different kinds of knowledge, and build adaptive capacity and resilience) but also as de facto disseminators of information and innovations [13,29,30].

A network is an "entity consisting of a collection of individuals and the ties among them" [31, p. 5]. Because they map out exchange among actors, network studies are particularly amenable to exploring how information and innovation "travel" or "diffuse" (or not) among different social actors beyond their immediate spatial and social context. In this sense, they can represent a powerful tool to complement place-based analysis of the interaction between producers and users of climate information. They can also help explain patterns of slow diffusion especially concerning preventive innovations such as using climate information for guiding adaptation and for disaster preparedness.

Through interpersonal contacts within networks, decision-makers get acquainted with new ideas, are able to "borrow" from other members'

experiences to gauge the compatibility of new tools with their own values and needs, and disseminate the advantages and disadvantages of these new tools to other potential users [32].

Although RISA teams have long been interested in where decision-makers go to access climate information, it is only fairly recently that some of the teams are formally studying the flow of information through networks and the role of knowledge networks in that information flow. In the context of RISAs, formal studies of networks, how they disseminate (or not) climate information or how climate information influences the role of networks in climate-related action have been relatively few (however, see [7,33,34]). Nonetheless, the potential for network studies to inform efforts to enhance climate information usability remains high for RISAs. This is particularly true regarding the influence longer-living RISAs might have had in fostering user networks beyond their originally targeted stakeholder groups. Some of the RISAs have started activities early enough to allow an assessment of how their first clients (early adopters) might have shaped (positively and negatively) knowledge dissemination through the many networks they populate. Moreover, network studies can identify how knowledge of different concerns about climate change impact evolves and amalgamates across different groups of researchers and stakeholders. For example, GLISA is now carrying out two studies that seek to identify how a knowledge network focusing on climate change in general and another on lake levels have evolved in the Great Lakes region. In the first case, the research tries to identify how the climate network has grown in the region since the early 2000s and the different roles organizations and personnel might have played in increasing diversity (across scales and sectors), scope and approaches to respond to climate change impact. The study then includes interviews with network members in the water sector to understand whether and how they use climate information. The second study focuses on meetings, mini conferences, and other venues in which climate change scientists encounter stakeholders and policy-makers with concerns in the Great Lakes region. It uses an analysis of the network structure to select subjects to be interviewed, making sure there are representatives of different types of venues, as well as those who bridged between venues. The study includes a survey of all the subjects focusing on their beliefs about lake levels and freeze–thaw cycles in the Great Lakes with the ultimate goal of learning how information about lake levels and freeze–thaw cycles circulates among scientists and policy-makers. Likewise, the Pacific RISA is currently identifying and mapping the flow of information and communication channels about climate and fresh water resources across the Pacific Islands region of the United States by applying a network survey to a large group of professionals.

The literature on diffusion of innovation identifies three groups of variables by three main categories that affect dissemination: characteristics of innovations, characteristics of innovators, and environmental context [35]. In the RISA-related literature, there is relatively robust empirical analysis focusing on the first two factors (see, e.g., recent literature reviews [36,16]); environmental contexts have been less explored [37], especially regarding the broader social networks where individuals make decisions and information disseminates. By mapping out both the strength of ties and the role of individuals in both disseminating and gate-keeping information, network studies may provide producers of climate information with critical knowledge to strategically target stakeholders and venues (two-mode networks) that can amplify information usability. They can also identify factors that build or undermine trust between personnel and explore the role of policy entrepreneurs to explain policy choice and the dissemination of policy innovation, and identify individuals who "bridge" different clusters thereby potentially accelerating information diffusion and policy-oriented behavior [33]. For example, a study carried out by CISA has found that in politically inhospitable environments, with limited support for explicit climate change activities, ad hoc networks, as well as having a variety of informal opportunities to meet and share information with other decision-makers, are important components of capacity building [38].

1.5 Factors affecting choice of methods

Generally, more engaged methods provide a more in-depth understanding of the decision-makers' concerns and help build long-term relationships, which are important to building and maintaining partnerships. The choice of methods takes into account the research questions, the types of decisions and decision-makers (e.g., farmers, state officials, community planners, federal agency) and the type of relationship researchers have with the decision-makers. It is important to be very clear about the benefits and goals of the research when regional partners are also research participants, especially where partners' actions are being "observed" by RISA researchers.

For many purposes, interviews or other participatory approaches can be used while working with regional partners to identify a smaller group of people with specific expertise, specific needs, or a deep knowledge of a group or issue. Certain research questions benefit from understanding the perspectives of high-level officials whose schedules and personal preferences may only accommodate short, focused telephone or in-person interviews. However, if one has developed a strong understanding of a topic when working

Table 1.1 Pros and cons of *formal* methods applied to understanding context research questions.

Methods	Pros (i.e., good for which purposes)	Cons (i.e., not as effective for which purposes)
Written questionnaires and surveys (on-line or mail)	Inexpensive (online), broad participation possible (gain perspective from variety of decision makers). Relatively easy way of creating baseline data for evaluation and longitudinal studies.	Does not provide an opportunity to query the specific data or information in which the participant is interested. May not provide enough context to develop appropriate engagement materials (e.g., handout, online tool). Online survey is ineffective when decision maker is not always near a computer (e.g., farmer), prefers interpersonal communication (e.g., tribal representatives) or is less accustomed to working via email/internet. Rates of return can be very low, especially if there is not a previous relationship with potential respondents.
Qualitative interviews (semi-structured or structured)	Promotes relationship building, depth of information, may foster future collaboration. Facilitates an understanding of individual or agency-specific needs. Allows for a two-way dialogue, and the interviewer can ask follow-up questions that clarify the interviewee's response.	Results often not generalizable. Transcribing interviews is time-consuming.
Participatory workshops and focus groups	Interactions can occur more broadly among participants as well as researchers; longer format can build rapport over multiple days. Allow for the progression of awareness to occur so that needs that may not be obvious in the beginning can become known. Similar to interviews, follow-up questions can be asked during a workshop setting, which allows the facilitator to get as specific information as possible, which can lead to meeting a need(s).	Limits number of participants. Requires substantial time commitment of stakeholders. Some groups can be dominated by one person.

(*continued overleaf*)

Table 1.1 (*continued*)

Methods	Pros (i.e., good for which purposes)	Cons (i.e., not as effective for which purposes)
Document analysis	Stable over time (i.e., can be referred to again and again); unobtrusive (avoid stakeholder fatigue). Can provide background and baseline understanding of decision context and stakeholder concerns.	Documents not always reflective of the full range of opinions; can be biased to certain perspectives; cannot be queried. All relevant documents may not be locatable; needed information may not exist.
Network analysis	Allow for the mapping of networks and understanding of nodes and strength of relationships (sociograms).	Formal network studies can be costly in terms of time and financial resources, especially when using snowballing sampling. Limited generalizability and level of embeddedness in social contexts, which can make exploring causal inferences challenging and necessitating further analysis (quantitative and qualitative) to identify drivers of specific behavior and outcomes [33,39]. Respondents often are reluctant to provide interviewer with names of other members of the network.

Document analysis includes the review and content analysis of documents relevant to the area of study, including documents such as meeting minutes, reports, white papers, operating plans, media reports, and the like. The pros and cons are cited from [40].

with a small group and one needs to understand how it applies to a large number of decision-makers (e.g., county emergency managers or farmers) across a large area, the scale, logistics, and expenses may make a written or e-mailed questionnaire the best approach.

It is important to find a balance between working with decision-makers as partners in the coproduction of knowledge and conducting social science research that involves studying the users of information (i.e., those very decision-makers with whom we are working to produce useful climate information). We also have to be careful to avoid "stakeholder fatigue" (as well as "researcher fatigue"), as these efforts require considerable investments in terms of staff time and resources and commitment from

Table 1.2 Pros and cons of *informal* methods applied to understanding context research questions.

Methods	Pros (i.e., good for which purposes)	Cons (i.e., not as effective for which purposes)
Participant observation	Promotes understanding of decision contexts and processes, interactions among participants.	Some decision makers and agencies may be uncomfortable being observed; participants are not as forthcoming with information. May not be able to ask questions and/or obtain the information for which you are looking.
Ongoing regional presence/ engagement	Improves effectiveness of outreach efforts. Builds trust with decision making community	Time consuming.
Co-production of research design and analysis	Obtain buy-in from decision makers from the start and throughout the research project. Improves decision maker's knowledge of science and the chances of his/her adoption of new information.	Decision makers do not always have the time, resources, and commitment needed to co-produce knowledge with scientists. Can lead to stakeholder fatigue. Desire of decision makers to use best and worst case scenarios can lead to unlikely projections.

both stakeholders and researchers. Formal surveys, interviews, trainings, and workshops (i.e., sustained and iterative interactions) are critical in supporting the overall process of producing useful information, but they are time-consuming and resource-intensive for all involved. Finding new and perhaps effective remote ways to engage stakeholders can help both to address these issues and to increase the ability of RISAs to reach a larger number of users. [7,22]

Using document analysis, web searches, participant observation (e.g., attending meetings, workshops), and informal interactions to obtain information about decision contexts allows RISA researchers to be sensitive to the time constraints of decision-makers, avoid stakeholder fatigue, and develop and deploy appropriate engagement methods. Moreover, using many sources of data and information allows researchers to integrate information and research findings and ultimately generate a deeper, more robust understanding of how climate information is used, and the political and social context in which decision-makers operate. RISA researchers try to avoid fatigue by building on and using existing efforts, sharing information across networks, and ensuring that there is a clear purpose in mind for stakeholder engagement activities.

For those wishing to pursue various approaches to understanding context, we have compiled Tables 1.1 and 1.2, which summarize the advantages and disadvantages of the different methods discussed earlier.

1.6 Conclusion

RISAs have extensive experience in research and engagement to understand the contexts in which managers, planners, agencies, and communities make decisions with respect to coping with and adapting to climate. A range and mixture of formal and informal research and engagement methods are used to understand these decision-making contexts. These methods are used to understand the existing context—a fundamental first step in effectively engaging those who are affected by climate—as well as potential contexts for information use. These methods are also helpful to determine the specific needs for improved science, services, and products. The mixture of methods often leads to a richer understanding of context as well as contributes to broader social science research on the human–environment interface.

One of the emerging questions for RISA teams is whether everything the team works on needs to be coproduced or whether some products can be developed by just knowing what the stakeholder needs and having an understanding of the context in which the information might be used.

The degree of coproduction needed is a complicated issue and one with which the RISAs are wrestling. Extensive coproduction could potentially contribute to stakeholder fatigue due to the substantial investment of time sometimes needed by stakeholders involved in the research project. The newly evolving area for RISAs of analyzing knowledge networks could shed light on this issue as we improve our understanding of how information flows across different organizations and the roles that these organizations play in producing or coproducing information.

Disclaimer

The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the authors and do not necessarily reflect the views of NOAA or the Department of Commerce.

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