PROJECT SUMMARY

Overview:

In order to better understand and navigate the rapidly changing Arctic, a research coordination network will be developed, largely driven and led by Indigenous organizations, to innovate and coordinate on the primary scientific theme of resilience and food security for Indigenous communities. To further broaden the perspective and insight, Arctic Indigenous communities will connect with tribes in the US Southwest, mainly in Arizona and New Mexico, to understand how Indigenous peoples, living in two environmentally extreme regions of the world, are adapting to rapid socioecological change to ensure food security. Understanding the resilience and food security of Indigenous communities requires diverse viewpoints and the convergence of deep disciplinary approaches that can be linked by the three secondary foci of the RCN: (2) Preservation, Visualization, and Sharing of Indigenous Knowledge (IK) Among Communities; (3) Access to Scientific Data and Information for Decision-Making by Communities; and (4) Indigenous Data Sovereignty, including Ethics and Control of Information and Knowledge. These themes will be guided and led by the RCN Steering Committee, including the PI Colleen Strawhacker (Overall RCN Coordinator, Univ. of Colorado), and co-PIs Peter Pulsifer (Theme 2 Lead, Univ. of Colorado), Daniel Ferguson (Theme 3 Lead, Univ. of Arizona), Stephanie Rainie (Theme 4 Lead, Univ. of Arizona), and Tristan Reader (Theme 1 Lead, Univ. of Arizona). Indigenous steering committee members and theme leads will be selected at first meeting to ensure diverse leadership and ownership over the project.

Intellectual Merit:

This network will add new and fresh perspectives to research on food security and resilience to the ongoing rapid social and environmental changes ongoing in the Arctic, by more effectively highlighting Indigenous sources of information. It is designed to grow convergence on issues related to resilience and food security for Indigenous communities by including multiple viewpoints from Indigenous Knowledge and Western Science, from academic scientists to tribal leaders. By connecting Indigenous groups in the Arctic and US Southwest, this RCN encourages an interregional and robust, interdisciplinary approach to this theme. The project will include interdisciplinary Western scientists focused on food security and resilience from both the social and physical sciences to discuss current research agendas, data availability, and encourage the direct engagement of Indigenous partners in ongoing scientific research. To link these varied viewpoints, the team will evaluate ongoing cyberinfrastructure and data platforms for scientific data and Indigenous Knowledge that may provide an effective venue to link our varied knowledge and datasets. The network will discuss potential ethical, access, and control issues for the sharing of data, including IK, to enable decision-making in Indigenous communities, leading to increased sovereignty for tribes over their data and Indigenous Knowledge via Indigenous data governance mechanisms that both tribes and others can utilize.

Broader Impacts:

The proposed RCN has the potential for enormous broader impacts for Indigenous communities in their ability to navigate the rapid social and environmental changes ongoing in both regions. These communities are often underserved and underrepresented in scientific research and are often among the poorest and most food insecure members of their respective regions. The development of the proposed network will result in the creation of relationships to other communities facing similar challenges and the discussion of alternative strategies for food security and resilience in both regions. This network is designed to empower communities to openly discuss these issues and create ideas for future projects and implementation of any discussed outcomes and needs of the communities. Additionally, this proposed network will create a plan for preserving and visualizing Indigenous Knowledge and connecting it to scientific data. These efforts will ensure that data and information will be more widely available to a number of different audiences and ensure sovereignty over information for Indigenous communities. Finally, this network engages scholars from diverse backgrounds, including women, early career researchers, and Indigenous members and leaders, ensuring diversity of perspectives and insight.

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*Proposers may select any numbering mechanism for the proposal. The entire proposal however, must be paginated. Complete both columns only if the proposal is numbered consecutively.

1.1: Introduction and Overview

The rapidly changing Arctic is resulting in serious threats to the resilience and food security of northern Indigenous residents (resulting, for example, in the forced relocation of Shishmaref, Marino and Lazrus 2015; or in decreased access to fisheries and harvest areas; ICC-AK 2016). This new Arctic socioecological regime is resulting in the loss of sea ice, melting permafrost, ocean acidification, and increasing development of the mining, oil, and gas industries. With these changes, access to traditional foods is transforming in unpredictable ways, resulting in increased food insecurity for rural Arctic villages (e.g., Fazzino and Loring 2009; Gerlach and Loring 2013; ICC-AK 2016; Kruse et al. 2011; Loring et al. 2009; McNeely and Shulski 2011). Governance and policies above the community level also threaten food security by restricting access to traditional food harvest areas (Caulfield 2000) and further highlight the need for actively engaging local communities in research and data collection so they can more effectively voice their needs (ICC-AK 2016; ITK 2016; Loring and Gerlach 2015). Changes in food security have serious consequences for the health and safety of Indigenous residents and the resilience of Arctic villages. By resilience, we draw upon the Arctic Council's recent overview of the topic, defining it as, *"The capacity of people to learn, share and make use of their knowledge of social and ecological interactions and feedbacks, to deliberately and effectively engage in shaping adaptive or transformative social-ecological change"* (2016: 8).

Indeed, learning how to navigate this new Arctic will require fresh, broad, and diverse perspectives, as well as increasing capacity for northern residents to respond to these changes, by creating networks with communities that are dealing with similar challenges and identifying data and information that can inform decision-making on the ground and inspire innovation to adapt to these changes. Numerous national and international reports reiterate the need to directly support Indigenous Arctic residents in scientific research and data collection to ensure their well-being and resilience and the environmental stewardship of the Arctic (Arctic Council 2016; CAFF 2017; IARPC 2016; NRC 2014a; USARC 2017). **To enable just this, we propose a research coordination network (RCN), largely driven and led by Indigenous organizations, to innovate and coordinate on the primary scientific theme of resilience and food security for Indigenous communities. Understanding resilience and food security requires diverse viewpoints and deep disciplinary approaches that can be linked by the three secondary foci of our RCN: (Theme 2) Preservation, Visualization, and Sharing of Indigenous Knowledge (IK) Among Communities; (Theme 3) Access to Scientific Data and Information for Decision-Making by Communities; and (Theme 4) Indigenous Data Sovereignty, including Ethics and Control of Information and Knowledge.** To further broaden the perspective and insight into these themes, we will connect Arctic Indigenous communities with tribes residing in the US Southwest, mainly in Arizona and New Mexico, to understand how Indigenous peoples, living in two environmentally extreme regions of the world, are adapting to challenges driven by these socioecological changes and the processes by which observations and data are assembled, recorded, and used in local decision-making.

In order to successfully navigate these themes, the proposed RCN will focus on converging Indigenous communities who will be joined by an interdisciplinary group of scientists (from ice scientists and land observers in the Arctic to climate scientists in the US Southwest to organizations dedicated to social science research) and data professionals (focused on creating digital tools and cyberinfrastructure to make data and IK more widely discoverable and accessible) (see Table 1 and Figure 1 for extensive details on the network nodes and acronyms referred to throughout the proposal). Through the exploration of

cyberinfrastructure and data access to support decision-making for Indigenous communities facing these rapid changes, we can ensure convergence of the diverse individuals and organizations in the network. Here, we draw upon the National Academies approach to *convergence:* "The key message of convergence… is that merging ideas, approaches, and technologies from widely diverse fields of knowledge at a high level of integration is one crucial strategy for solving complex problems and addressing complex intellectual questions underlying emerging disciplines" (NRC 2014b: 21). Indeed, our proposed RCN does just this, by focusing on a scientific theme - *resilience and food security* - often approached by interdisciplinary scientific teams through the additional perspective of the deeply embedded local and IK of communities living in both the Arctic and the US Southwest (e.g., CAFF 2017; Crimmins et. al. 2015; Diné Policy Institute 2014; ELOKA 2015; ICC-AK 2016; Overpeck et al. 2013; Pulsifer et al. 2012, 2014). We then explore how to merge these ideas and approaches through the technology and lens of cyberinfrastructure and digital platforms that can provide a venue to ethically and holistically link these diverse communities and interdisciplinary knowledge systems and datasets for decision-making on the ground by Indigenous communities in the Arctic.

1.2: Project Aims and Objectives

Our proposed RCN is anchored by Indigenous-led organizations (e.g., Inuit Circumpolar Council-Alaska, the Gila River Indian Community, and the Inter-Tribal Council of Arizona), scholars with deep experience in interdisciplinary research on resilience and food security (e.g, Climate Assessment for the Southwest and dataARC), and practitioners with extensive experience in building digital and governance infrastructure for IK and scientific data (e.g., US Indigenous Data Sovereignty Network, the Exchange for Local Observations and Knowledge in the Arctic, and the National Snow and Ice Data Center). To expand the development from our proposed network to others, we directly engage a number of complementary networks, including the Interagency Arctic Research Policy Committee and the Research Data Alliance. The aims of the proposed network will be to:

- Build convergence on issues related to resilience and food security for Indigenous communities by connecting Indigenous groups in the Arctic and the US Southwest, encouraging an interregional and robust, interdisciplinary approach to this theme.
- Bring interdisciplinary Western scientists focused on food security and resilience from both the social and physical sciences together with Indigenous organizations, networks, and community representatives to discuss current research agendas, data availability, and help facilitate the direct engagement of Indigenous partners and IK in ongoing scientific research.
- Evaluate ongoing cyberinfrastructure and data platforms for scientific data, IK, and observations that may provide an effective venue to link our varied knowledge sources and datasets.
- Discuss potential ethical, access, and control issues for the sharing of data and observations, including IK, to enable decision-making in our communities, leading to increased sovereignty for tribes over their data and IK via Indigenous data governance mechanisms.

In order to achieve these ambitious objectives, the proposed RCN will (1) hold a series of workshops in both the Arctic and the US Southwest, with agendas and meeting plans being directly led by Indigenous partners, (2) create a social network platform of choice by the RCN group (e.g., Facebook, Twitter) to be decided during the opening meeting, (3) hold teleconferences directly after in-person meetings and at regular intervals to inform the entire network of progress and ideas, (4) create a project website, hosted by ELOKA, to exchange information and reports resulting from meetings and teleconferences and publicize outcomes throughout the project, and (5) engage with other affiliated networks to ensure broad reach of

RCN outcomes. *Through these efforts, we will produce new linkages of previously disparate networks and groups, resulting in new and innovative projects and ideas on our RCN themes with fresh perspectives on the new Arctic concerning resilience and food security.*

1.3: Intellectual Merit: Connecting Arctic and SW Communities: IK and Food Security and Its Importance for Navigating a New Arctic

The efforts outlined above will empower Indigenous communities in the Arctic to network with partners in other parts of the world and have a venue to discuss the needs specific to them to fully understand how to navigate the changes ongoing in the region. In addition to *Navigating the New Arctic*, this proposed network will have direct implications for four of the 10 Big Ideas that NSF has identified for future investment, including *Harnessing Data for 21st Century Science and Engineering, NSF INCLUDES: Enhancing Science and Engineering through Diversity,* and of course, *Growing Convergent Research* (NSF 2016). This project will explore how to link systems, data, and perspectives from multiple domains (including geological, biological, and social sciences, as well as experience from data professionals) and IK, and will be driven by the communities in the Arctic and the US Southwest, thus increasing their ability to participate in STEM and drive research and data agendas, to address community well-being and resilience challenges. While the new Arctic is unique in many respects, lessons learned from other regions can be incredibly valuable, just as lessons from the Arctic can be valuable to those living in other extreme regions, like the US Southwest. This proposed RCN capitalizes on many ongoing initiatives in both the Arctic and the US Southwest by connecting them for a more holistic approach to resilience and food security, resulting in:

1. *Convergence of Multiple Viewpoints from IK and Western Science, from Academics to Tribal and other Indigenous Leaders to Navigate the New Arctic:* Members of the proposed network will discuss best ways to integrate data and information from both interdisciplinary sources in Western science (e.g., climate and environmental data) and IK through the lens of cyberinfrastructure and digital tools as a convening space. Although different from Western science, Indigenous observations and ways of knowing offer valuable sources of knowledge for scientists and beyond (Berkes 2008; Cajete 1999; Krupnik and Jolly 2002; McGregor 2004). Thus, this project provides access to diverse perspectives on and processes for interpreting environmental and social change from varied viewpoints for more rigorous scientific endeavors and engagement of local Indigenous peoples in understanding the effects of socioecological change in the Arctic and the US Southwest.
2. *Exploration of Best Practices to Share and Access to High Quality Data and Knowledge on Food Security for the Arctic and the US Southwest*: The availability and need to share knowledge, data, local observations and solutions among communities in the Arctic and the US Southwest and among scientists, has been highlighted by IK holders in the recent ICC-AK food security report (ICC-AK 2016) and numerous other scientific and international reports on furthering Arctic research (e.g., CAFF 2017; Pundsack et al. 2013). While geared toward the needs of Indigenous communities in this network, these data and knowledge sources will also be of intrinsic value to scientists working on climate and food issues in the Arctic and the US Southwest, by making these data (much of which are stored on university servers and not readily accessible) more widely available to other partners. Because a variety of social and environmental drivers affect food security, this project will network on best practices to make data and knowledge available to address complex questions across multiple spatial and temporal scales.

1.4: Indigenous Knowledge for Food Security and Resilience in the Arctic and the US Southwest

Food security issues in the Arctic, as elsewhere, are dictated by a complex socioecological system and, for Indigenous peoples, are deeply integrated with social, economic, cultural, and ecological aspects of life, necessitating the perspectives of multiple disciplines and viewpoints. Defining and measuring food security (and insecurity) in the Arctic has only recently become widespread in scope with efforts focusing on traditional harvesting practices, as well as cultural and economic importance for the resilience and well-being of northern communities (AHDR 2004, 2015; Duhaime & Bernard 2009; Daveluy et al. 2011; NAS 2006, 2014). Defined from an Inuit perspective (ICC-AK 2016), food security allows for people to obtain, process, store, and consume healthy and nutritious food, which can provide for families and future generations through the practice of Inuit customs and spirituality, languages, knowledge, policies, management practices, and self-governance. It includes the responsibility and ability to pass on knowledge to younger generations, the taste of traditional foods rooted in place and season, knowledge of how to safely obtain and prepare traditional foods for medicinal use, clothing, housing, nutrients, and how to interact in the environment. Inuit food security is characterized by environmental health and consists of six interconnecting dimensions, including: 1) Availability, 2) Inuit Culture, 3) Decision-Making Power and Management, 4) Health and Wellness, 5) Stability, and 6) Accessibility. This definition shows that Indigenous people take a holistic, convergent approach to the relationship between food, subsistence, and climate that can also better inform potential convergent scientific approaches.

The rapid environmental and social changes in Arctic and the US Southwest are no doubt stressing the ability to successfully acquire food in both places (Archer et al. 2017; Berkes 2009; Crimmins et al. 2015; Diné Policy Institute 2014; Ford et al. 2006; Krupnik and Ray 2007). A recent study by Gaffney and Steffen (2017) found that, at this point in time, the climate is changing 170 times faster than previously observed in history. This unprecedented rapidity of change is challenging the reliability of local and IK upon which communities are reliant for subsistence foods (e.g., Martin 2015). For example, many studies have linked ongoing climate change to an increased risk of extreme and unpredictable events, including flooding, drought, dust storms, and fire, threatening the resilience of Arctic and Southwestern communities (NAS 2016; Stott 2016; Ummenhofer and Meehl 2016). Deeply embedded local and IK can often mitigate risks to these hazards, but changes in the patterns due to ongoing climate change can threaten the reliability of this local knowledge when it comes to mediating the consequences of this rapid change (Nelson et al. 2015; Strawhacker 2017).

Both the Arctic and the US Southwest regions, given their extreme environmental conditions, are experiencing these changes exponentially (Overpeck et al. 2013), and share many environmental and cultural similarities that connect their experiences, but with different regional environments that allow for new perspectives into complex issues and solutions to unique challenges. Indigenous communities in both the US Southwest and the Arctic have procured resources from these extreme environments for millennia, drawing upon generations of deeply embedded knowledge to ensure food security for centuries (e.g., Nelson et al. 2015; Reader 2017). Today, both of these regions have well-organized tribal and Indigenous organizations at local, regional, national, and even international levels, allowing for information to be shared and partnerships to be extended within and among communities. *Despite vastly different regional climates, Indigenous communities in both regions have identified challenges to food security related to increasing problems due to dust, fire, and water, all of which can be potential themes for discussion as the network develops and identifies further topics that may connect these communities.*

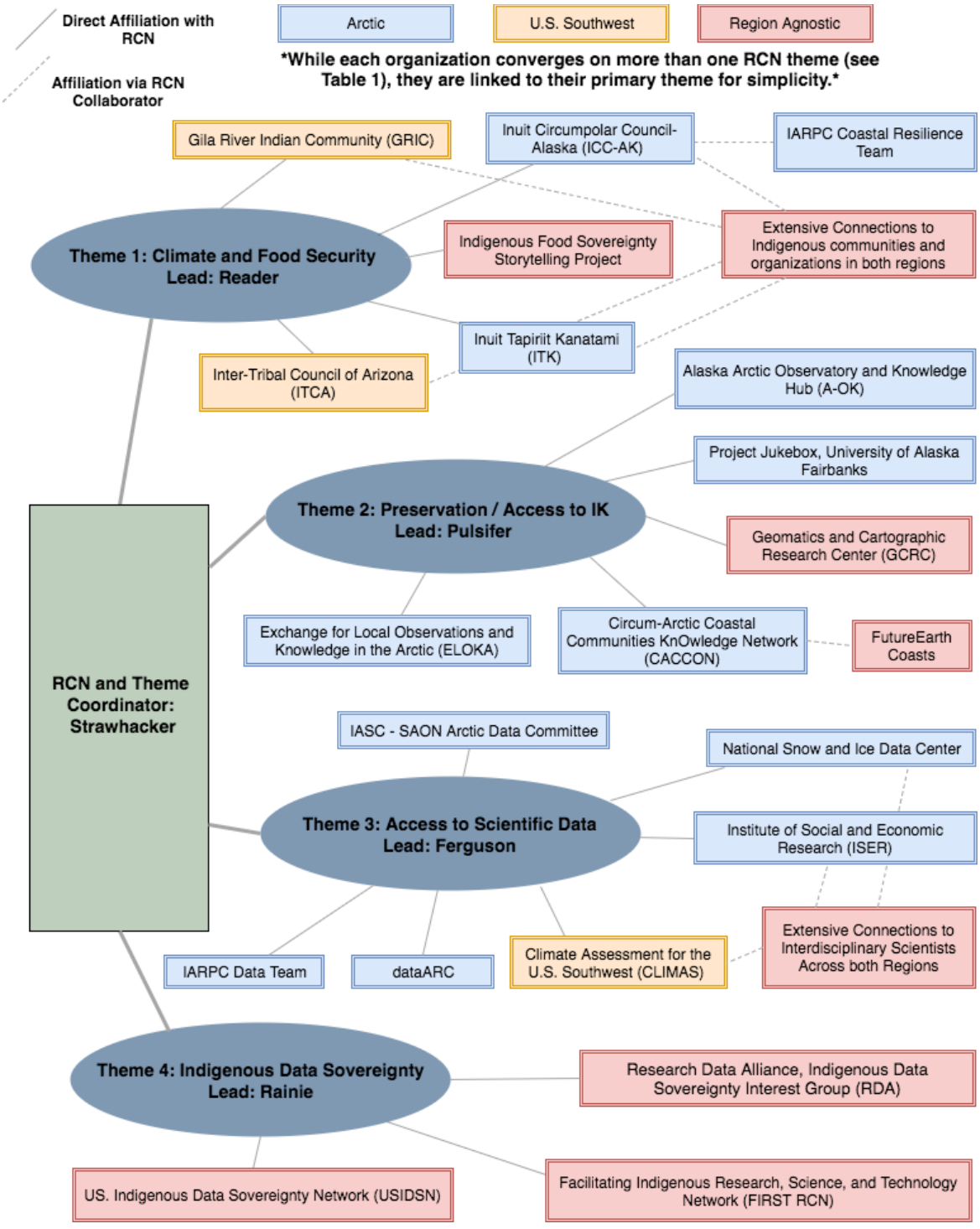
Arctic communities are increasingly observing and documenting their changing relationships with fire, dust, and water (in many forms, including sea ice, glaciers, and rivers). A recent increase in unpredictable fires has resulted in damage to habitat areas and loss of subsistence plants and animals (e.g., Murray et al. 2017) and rapid sea ice loss has threatened the reliability of walrus hunts (SIWO 2017). Anthropologists have also recently observed that Arctic communities have mentioned increased problems with dust in their villages (RCN collaborator Schmidt, personal communication), but the issue of dust in the Arctic and its relationship to food security has been little studied thus far in the region. These changes around fire, water, and dust are ongoing in the Arctic and have a wide range of consequences. For example, the retreat of the Kaskawulsh Glacier in Canada resulted in "river piracy," in which glacial outwash was drastically and quickly rerouted to other rivers (Shugar et al. 2017). While this study did not analyze the effects that river piracy would have on Indigenous communities, a change this exponential on an occupied river would have devastating consequences for subsistence activities, including fishing. Related to this threat to Arctic rivers, recent dismal salmon runs on major rivers in Alaska have become increasingly unreliable, forcing local residents to fish during unsafe conditions, forgo fish camps, process fish in less than ideal conditions resulting in lost time and fish, replacing salmon with other wild foods, or purchasing expensive non-traditional food from stores (Brown and Godduhn 2015; Ikuta et al. 2013).

Many of these challenges faced by Arctic Indigenous peoples are similar to those mentioned by communities in the US Southwest. For example, in 2008 the Ethan Fire charred 6,600 acres on the Gila River Indian Community (GRIC), resulting in nearly $700,000 in resources spent as well as 200 firefighters to contain the wildfire and save residential housing, not to mention the destruction of agricultural crops. While wildfires on the GRIC can have very real consequences for people living there, these fires also have impacts on air quality across the Community, as does the increasing threat of dust to the health of Community members (Wright et al. 2013). Increasing hazards of dust and fire have been linked to ongoing climate change, doubling since the 1990s (Tong et al. 2017), and are tied to soil quality, which drives agricultural and food production (Strawhacker 2013; Wright et al. 2103; Wright and Fertelmes 2012). Intrinsically tied to these threats is water (which, in the US Southwest, takes quite a different form than water in the Arctic) and the success of agricultural production, upon which Southwestern communities procured the majority of their food in the past. Access to water is a major environmental and political issue for agricultural production in the region (e.g., see the 2004 Water Settlement to the GRIC, ADWR 2017), with an unprecedented risk of drought in the 21st century in the Southwest seriously threatening food production in the region (Cook et al. 2015).

It is clear that Southwestern and Arctic Indigenous communities need to adapt to their rapidly changing environments to ensure food security and resilience to these changes in the future (e.g., Duerden 2004). By providing access to data, IK, and best practices, and through the development diverse networks, communities will be able to make better informed decisions, thus enhancing food security and community well-being. In turn, by working with communities to better understand what data they use to make decisions, the proposed network can also help inform scientific theory and modeling efforts directed at addressing food security issues for Indigenous communities in both regions. It is clear that the ability to study trends in food security across the Arctic and the US Southwest requires a wide range of data and knowledge that operate at multiple temporal and spatial scales. The scientific community has collected extensive high quality data on subsistence and food security across the Arctic and the US Southwest. ***Yet despite the amount of valuable, high quality data and knowledge related to food security across both***

regions, challenges with data discovery, access, heterogeneity, and interoperability remain. This project is designed to connect networks on issues of food security and resilience with cyberinfrastructure and data products as the link to converge our diverse viewpoints, knowledge sources, and datasets to more fully understand and holistically address these complex issues.

Figure 1: RCN Nodes and Organizations



1.5: Timeliness of the Proposed RCN: Initial Collaborative Work Leading to Convergence

The PI leadership and affiliated organizations committed to participating in the RCN represents an incredibly wide and diverse network of Indigenous communities, interdisciplinary scientific organizations, and data professionals, allowing for true convergence of ideas and innovation to occur during the formation and growth of this network on the topics of resilience and food security. The broad, interdisciplinary team identified for this RCN has extensive experience in building essential networks to coordinate interdisciplinary science (e.g., PI Strawhacker's efforts in coordinating researchers on climate and archaeology in both the Arctic and the US Southwest, including the dataARC project) and cyberinfrastructure (e.g., IASC-SAON Arctic Data Committee and the IARPC Data Coordination Team, both led by Pulsifer, as well as ELOKA, co-led by Pulsifer and Strawhacker). Similarly, nascent efforts in the US Southwest to build networks and capacity for Indigenous data sovereignty (USIDSN, led by Rainie) and building capacity for dealing with environmental changes at a local (i.e., community) level (CLIMAS, led by Ferguson) make the proposed team ideal to link these regional efforts together for a truly interregional and convergent approach to our RCN themes (Table 1 and Figure 1).

*Table 1: Affiliated Network Partners for the RCN, *indicates Indigenous-led organization, ^ indicates female-led.*

Partnered Organization (Affiliated Personnel)	Description	Theme of Expertise
Arctic		
^ Exchange for Local Observations and Knowledge of the Arctic, ELOKA (Pulsifer and Strawhacker)	ELOKA facilitates the collection, preservation, exchange, and use of local observations and knowledge of the Arctic. ELOKA provides data management and support, and fosters collaboration between resident Arctic experts and visiting researchers.	1, 2, 3, 4
^ dataARC (Strawhacker and Pulsifer)	dataARC builds digital infrastructure to discover data facilitating interdisciplinary research (via the lenses of archaeology, paleoclimate, and the humanities) on the long-term human ecodynamics of the North Atlantic.	1, 3
^ Alaska Arctic Observatory and Knowledge Hub, A-OK (Lee)	A-OK builds resources to share information from community-based observations on cryosphere change conducted by northern Alaska communities.	1, 2, 3
^ Ann Riordan (Calista Education and Culture)	Riordan is an independent scholar working closely with ELOKA on developing training materials focused on IK for the Lower Yukon School District in Alaska.	1, 2, 4
National Snow and Ice Data Center, NSIDC (Strawhacker and Pulsifer)	NSIDC manages and distributes data, creates tools for data access, supports data users, performs scientific research, and educates the public about the cryosphere.	3
Circum-Arctic Coastal Communities KnOwledge Network, CACCON	CACCON is a network of communities and engaged local and regional knowledge centers exchanging information and solutions, within and between peer communities, in the	2, 4

(Slaney, Forbes, Bell)	circumpolar north to enhance the resilience and well-being of people in Arctic coastal communities through advancing local knowledge availability and accessibility.	
*Inuit Tapiriit Kanatami, ITK (Nickels)	ITK serves as a national voice protecting and advancing the rights and interests of Inuit in Canada.	1, 4
*Inuit Circumpolar Council - Alaska, ICC-AK (Behe)	National organization working on behalf of Inuit communities in Alaska, led the creation of a major Arctic food security report.	1, 4
^ Institute of Social and Economic Research, ISER (Schmidt)	Academic department dedicated to social science research and data for the Arctic, based at the University of Alaska, Anchorage	3
^ Project Jukebox, University of Alaska Fairbanks (McCartney)	Project Jukebox is the digital branch of the Oral History Program and provides access to audio and video recordings, transcripts, maps, historic photographs and films from across Alaska.	2, 4
Arctic Data Committee (Pulsifer and Strawhacker)	International Arctic research data coordination group for the International Arctic Science Committee (IASC) and Sustaining Arctic Observing Networks (SAON)	3, 4
US Southwest		
* Gila River Indian Community, GRIC (Walker)	Community organization for members of both the Akimel O'odham (Pima) and the Pee-Posh (Maricopa) tribes in southern Arizona.	1, 4
Climate Assessment for the Southwest, CLIMAS (Ferguson)	CLIMAS employs experts from a variety of social, physical, and natural sciences who all work with partners across the Southwest to develop sustainable answers to regional climate challenges.	1, 3
*^ Inter-Tribal Council of Arizona, ITCA (Lane)	ITCA provides a united voice for tribal governments located in the State of Arizona to address common issues of concerns and promotes Indian self-reliance through public policy development. ***Organizes dozens of tribes in Arizona, expanding our SW Network extensively.***	1, 2, 4
* Indigenous Food Sovereignty Storytelling Project (Reader)	The Indigenous Food Sovereignty Storytelling Project draws upon the collective experience and wisdom of community efforts to explore the themes, approaches, and most effective strategies for building tribal food sovereignty.	1
Region Agnostic		
*Facilitating Indigenous Research, Science, and Technology Network,	FIRST is an interdisciplinary network of Native scholars all working at the intersection of Indigenous and Western scientific traditions to explore how Indigenous communities	1, 2, 3, 4

FIRST RCN (Johnson)	are utilizing both traditions to meet their research needs.	
*^ US Indigenous Data Sovereignty Network, USIDSN (Rainie)	USIDSN helps ensure that data for and about Indigenous nations and peoples in the US are utilized to advance Indigenous aspirations for collective and individual well-being. Its primary function is to provide research information and policy advocacy to safeguard the rights and promote the interests of Indigenous nations and peoples in relation to data.	2, 3, 4
Geomatics and Cartographic Research Center (GCRC), Carleton University (Taylor)	GCRC applies the application of geographic information processing and management to the analysis of socio-economic issues of interest to society from the local to the international scale and the presentation of the results in new, innovative cartographic forms.	2, 3
^ Research Data Alliance (Yarmey)	RDA provides a neutral space where members can come together to develop and adopt infrastructure that promotes data-sharing and data-driven research, and accelerate the growth of a cohesive data community that integrates contributors across domain, research, national, geographical and generational boundaries.	3, 4

The affiliated partners represent an enormous network in both the Arctic and US Southwest, with insight from local, national, and international organizations that have links to both regions, in all of the proposed RCN themes (see Figure 1). They also represent a variety of institutional affiliations from national Indigenous organizations, to academic departments, to independent scientific projects, to informal established networks, to international coordination efforts. The proposed network's ability to connect and harmonize goals and outputs represents an unprecedented opportunity to link Indigenous and scientific approaches to a complex topic in two environmental distinct regions of the world.

Available Data and Existing Cyberinfrastructure to Address Themes 2, 3, and 4

In addition to an interdisciplinary team, the affiliated organizations and individuals have worked on creating digital infrastructure to enable accessibility, discoverability, and interoperability of scientific data, IK, and local observations. The experience of the team, anchored by the NSF-funded work by ELOKA, will allow us to discuss how to best converge our various themes, issues, and disciplines into a system(s) designed for our end audiences - our Indigenous networks in the Arctic and the US Southwest - with potential data services provided to other audiences. Table 2 shows the ongoing platforms developed by the PI team that will serve as the basis for brainstorming how to best link our RCN themes.

Table 2: Established Technical Nodes of Project (NSF Award Numbers Indicated)

Organization	Existing Cyberinfrastructure	Types of Data, Information, and Knowledge
ELOKA (PLR 1231130, 0632345,	Yup'ik Environmental Knowledge Project (PLR 1021496)	Thousands of place names and related environmental features; associated multimedia (audio files of placename, video narrative,

0856634, 1513438) (Pulsifer, Strawhacker)		photos, etc.); cultural (stories) and historical modules within atlas
	Semantic Sea Ice Interoperability Initiative (SSIII) (PLR 0956010)	Ontologies (vocabularies and relationships) of sea ice and other l themes from Indigenous, scientific and operational perspectives
	Koyukuk Place Names Atlas and others (PLR 1415516 - UAF Collaboration)	Hundreds of place names and related environmental features; associated multimedia (e.g. audio files of placename, video narrative)
	The Seasonal Ice Zone Observing Network (SIZONet) (PLR 0856867)	More than five thousand observations of environment (ice, weather, terrestrial), wildlife and subsistence collected over a decade.
NSIDC	dataARC (SMA 1439389 and 1637076) (Strawhacker, Pulsifer)	Data linking and visualization for multidisciplinary data for climate and archaeology (Strawhacker 2015a, b)
	Permadata (PLR 1416712) (Strawhacker, Pulsifer)	Aggregate, extract, standardize, and reorganize data by integrating valuable data holdings on permafrost from international organizations

Themes for the Proposed RCN

The four proposed RCN themes have been consistently identified by Indigenous partners (e.g, Crimmins et al. 2015; DPI 2014; ICC-AK 2016) as essential to understanding and adapting to rapidly changing environments and how Indigenous communities, who are often on the front lines of this change and reliant on subsistence activities, can be better equipped to address that change.

Primary Scientific Theme: Resilience and Food Security for Indigenous Communities: The network will connect Arctic and Southwestern communities to discuss the varied stressors and challenges in procuring food and resources from their rapidly changing environments, to ensure resilience and health of Indigenous communities in both places (see Section 1.5). The complexity of addressing questions regarding our primary theme requires multiple disciplines and knowledge sources to address, so Themes 2, 3, and 4 have been designed to be the unifying architecture to address and structure discussions around our scientific theme. These secondary themes will provide platforms to translate across disciplines and ways of understanding the world to ensure true convergence on this topic.

Theme 2: Preservation, Visualization, and Sharing of Indigenous Knowledge Among Communities: Primarily, our Indigenous partners will discuss the importance of their knowledge for dealing with climate uncertainty and food security. Through the infrastructure of the proposed network, we will discuss and identify the challenges of and opportunities to maintaining this knowledge and the importance of sharing IK within and among communities. Using ELOKA's extensive experience in creating digital atlases and databases for IK (Table 2), we will demonstrate and brainstorm appropriate platforms and features for the sharing of IK among Arctic and Southwestern communities.

Theme 3: Access to Scientific Data and Information for Decision-Making by Communities: In addition to IK, Indigenous people in both regions often state the desire for access to scientific data as a

complementary resource to their local observations and IK (ICC-AK 2016; ITK 2016; Redsteer et al. 2013). During the development of the network, Indigenous peoples in both regions will discuss sources of scientific data that would be useful and how to best share and display this data to truly complement their IK and to have maximum impact for local decision-making.

Theme 4: Indigenous Data Sovereignty, including Ethics and Control of Information and Knowledge: Importantly, IK often contains sensitive information and the long history of colonialism in both regions has resulted in IK, developed over millennia by their Indigenous owners, being used and shared without permission. This sensitive information can include locations of sacred sites, identifiable information of Indigenous persons, as well as information about the migration or nesting patterns of endangered species. Both ELOKA and USIDSN have deep experience in negotiating this delicate balance of ethically governing information to preserve Indigenous control and protect Indigenous data.

1.6: Methodology: Research Coordination Network Activities Plan and Management

We will connect and solidify this network through a variety of venues, including a series of in person meetings and workshops centered around our RCN themes and further complementary themes identified by Indigenous partners. These periodic workshops of the collaborative group will serve to solidify goals and themes for the developing network, identify data and information sources and research goals, obtain feedback from the expertise within the group, and create a plan for solutions to the challenges for resilience and food security for Indigenous communities. These workshops have been planned to overlap with complementary meetings associated with other collaborations to save costs and to capitalize on including other collaborators who have yet to be identified. The first and final meetings will be held in central locations (Anchorage and Tucson) to provide maximum opportunity for attendance by collaborators in both regions, despite limited budget. Quarterly teleconferences - with special teleconferences held directly after each in person meeting - will be held given that in person meetings will be limited and focused on specific topics and themes. The wider community will then be allowed to provide thoughts on progress made at in person meetings and contribute input on how the network and ideas are developing. At these meetings, Strawhacker will document ideas and thoughts and distribute via social networks, as well as through the project website.

In addition to these in person meetings and teleconferences, the network will connect via online tools, including the development of a social network and project website specific to this RCN (hosted by ELOKA), as well as leveraging other networks (including IARPC, RDA, and the FIRST RCN) that provide venues to connect to other Indigenous and scientific organizations. Indigenous communities in both the Arctic and US Southwest have relied largely on Facebook to share information and coordinate activities, so we will likely build upon this platform to ensure communication across the network (e.g., refer to the Sea Ice for Walrus Outlook Group on Facebook). Future projects will build upon the progress made in these workshops to implement the plan for sharing information, build interoperable databases, and then operationalize the identified research questions and outreach goals.

Year 1: Establishment of Network, Introductions, Indigenous Steering Committee Identified: Two workshops will be held in Year 1 to establish momentum and key partners in the proposed network. The first meeting will be centrally located in Anchorage to ensure broad reach to potential Arctic collaborators (including University of Alaska, Anchorage and ICC-AK), but will be well-attended by Southwestern Indigenous partners, as well. During this first meeting, Indigenous theme leads and steering committee

members will be identified, as well as appropriate online venues to connect in between in person meetings. To ensure full Indigenous ownership over the project, we will discuss the branding of the RCN, including a name and logo, to encourage recognition within and outside of the defined RCN nodes. A second meeting will be held by an Indigenous partner in the US Southwest (both GRIC and ITCA have offered to host meetings thus far) to provide an opportunity to discuss the challenges faced by those living in the US Southwest. Both meetings in Year 1 will provide an opportunity to overview the challenges to food security brought about by the rapid changes occurring in both regions and identify key differences and opportunities for collaboration in these two regions.
Outcomes by End of Year 1: With the first two in person meetings held, as well as a series of teleconferences, the core team (outside of identified PIs) will be solidified, with Indigenous community members placed in leadership roles on the project. The team will determine plans on how to continue networking in between in person meetings and establish the social networks of preference.

Year 2: ***Piloting of Platforms, Cyberinfrastructure of Interest to the Community:*** One workshop during this year will focus on Themes 2 and 3 and how data and cyberinfrastructure can help Indigenous communities with decision-making on the ground in both regions. This meeting and associated teleconferences and networking will include intensive demos of operational and ongoing ELOKA products (Table 2), led by the ELOKA team and Indigenous partners. These activities will identify the data, information, and knowledge sources that may be of interest to the community and brainstorm platforms and functionality that can help share this information to a wide variety of audiences.
Outcomes by End of Year 2: A report, led and authored by steering committee members and other interested parties, will outline the desired access to data and knowledge sets and features of potential data and cyberinfrastructure platforms that may better enable sharing and discoverability of appropriate data and IK to inform decision-making by Indigenous communities in both regions.

Year 3: ***Reevaluation of Themes, Redirection if Needed Based on Feedback by Network:*** One in-person workshop will be held with discussions ongoing via the social network and the regular teleconferences. Meetings will be focused on theme 4 (Indigenous Data Sovereignty) on how to best share and visualize IK in an ethical manner with a critical evaluation of the report produced in Year 2. This report and associated products will be presented to our various networks, with feedback solicited from both our internal RCN group as well as other collaborators who may wish to review and provide comments.
Outcomes by End of Year 3: A revision of the report produced in Year 2, with the addition of concrete platforms and ideas for the construction of digital tools and cyberinfrastructure to link our 4 RCN themes.

Year 4: ***Identification of Next Steps, Ensuring Sustainability of Network after Financial Support Ends:*** Two workshops will be held during the final year of the project to ensure sustainability of the network and appropriate planning for next steps after financial support ends for this proposed RCN. The first workshop will be held in an Arctic community (TBD, depending on how the network evolves over the first 3 years) with the closing workshop centrally located at the University of Arizona to maximize participation. During this final year, the network will meet regularly to discuss lessons learned on the 4 RCN themes and continue to outreach to affiliated organizations to solidify and expand the network as well as link to other complementary efforts ongoing in each region.
Outcomes by End of Year 4: See Section 1.8 for overall project outcomes and success metrics.

1.7: Management Plan of the Proposed RCN

Strawhacker, as the lead PI, will take responsibility for the coordination and management of the entire proposed network, with the budget hosted at her home institution, the National Snow and Ice Data Center. Her extensive research experience in the proposed RCN themes, as well as history in working with Indigenous communities and interdisciplinary scientists in both the Arctic and US Southwest make her an ideal candidate to lead and coordinate this network. Her leadership experience as the co-PI of ELOKA and lead PI of dataARC will ensure appropriate communication across all nodes of the distributed network and fair distribution of funds across the team.

At an administrative level, Strawhacker and Pulsifer will coordinate all participant support to meetings and maintain and grow partnerships with Arctic communities, while University of Arizona collaborators will coordinate with our partners in the US Southwest. In order to ensure sovereignty and ownership over the network and meetings, Indigenous partners (including the GRIC, ITCA, and ITK) will locally organize and run meetings with administrative assistance from NSIDC and the management and research assistance from the PI team. The meetings will be held predominantly in local communities and locally organized by our affiliated Indigenous organizational partners with the opening and closing workshops being located at regional hubs (Anchorage and Tucson) to ensure maximum participation by affiliates. Funds have been allocated for both participant support to fund meeting attendance and for our Indigenous partners to assist with local organizing of workshops.

Increasing Diversity. With strong leadership on the PI team and the desire to have this project be Indigenous-led and driven, the proposed RCN will be loosely and flexibly organized by the core group of organizations that have agreed to collaborate (Table 1 and Figure 1) to identify individuals that would be best to network in these meetings. Given responsibilities in home communities to harvest crops or captain whaling ships (among many other possible obligations to subsistence activities), no one individual will be expected to attend all meetings, but organizations will select individuals and manage how they will interact with the developing network, allowing for a truly collaborative and extensive network to develop. As such, the management will be flexible and evolve based on the needs of the involved organizations.

Steering Committee. Initially, the steering committee will consist of the PI team of this proposed project, including Peter Pulsifer (NSIDC, CU), and University of Arizona collaborators, Rainie, Ferguson, and Reader. While Strawhacker will coordinate the network and the development of associated RCN themes, the RCN co-PIs will act as theme leads to ensure appropriate progress (and redirection, if necessary) is made (Figure 1). At the opening meeting, affiliated Indigenous partners will be selected as steering committee members and RCN theme co-leads for the future of the network.

Information and Material Sharing. Given our fourth RCN theme - *Indigenous Data Sovereignty, including Ethics and Control of Indigenous Knowledge* - information and material sharing will be a key topic of conversation throughout the development of the proposed network, given the potential sensitivities involved in sharing and publicizing IK. To this end, the team understands the importance for communicating across a wide and diverse network to ensure progress and participation among our affiliated partners and to grow the network as it develops and plans to follow guidelines set forth by IASC on *ethically open data* (IASC 2013). The combination of in-person meetings, regular teleconferences, and the establishment of a project social network and website will ensure communication across the network.

Project results will be made available to the public via our project website and our outreach efforts, but any potentially sensitive information (including locations of sacred sites or endangered species) will be removed from public documents in close consultation with our Indigenous partners. In ELOKA's and USIDSN's experiences, Indigenous partners are often willing to share information if trust is obtained and built through close relationships, so the restriction of any material to the general public will ensure that the network can succeed and trust can be maintained (see also Gearheard and Shirley 2007).

Coordination Plan. To continue to expand our network, the PI team and affiliated network nodes are well-connected to a variety of networks and will outreach to our partnerships during the project. The team will present to partnered organizations (including, but not limited to, IARPC, Future Earth Coasts, the Arctic Data Committee, and the RDA) throughout the development of the project. The extraordinary connections among the current steering committee via multiple different types of Indigenous, scientific, and data networks, allows for the network and outcomes to be communicated to a number of different domains in our two identified regions. For example, Rainie's PhD student - Desi Rodriguez-Lonebear - has recently been selected as an Early Career Fellow with the RDA and has assisted with the creation of Rainie's RDA Interest Group on Indigenous Data Sovereignty. This connection will be invaluable to outreach to the international data community on the intricacies of sharing and visualizing IK.

1.8: Planned Outcomes and Success Metrics

The ideal outcome of any developing network is the creation of new projects pursued by the newly connected communities, empowered with better formed ideas and supported by the knowledge and resources developed during the creation of this network. While the Arctic and US Southwest are regionally disparate groups, tribes and Indigenous organizations are well-organized regionally, providing an opportunity to fully engage and operationalize outcomes from the RCN in both regions. Indeed, the primary focus will be to gain fresh perspectives on the new Arctic while identifying the concrete challenges, data sources, and digital platforms that would be of most use to Indigenous communities while expanding networks to others facing similar challenges in other parts of the world. While the group will initially focus on dust, fire, and water as linking challenges to food security and resilience, this network will no doubt explore areas of similarity and divergence and best opportunities to build upon those to increase capacity in each region.

Concretely, the network participants will create a series of reports based on of outcomes of in-person meetings and conversations within established social networks and teleconferences. These reports and findings will be distributed throughout the RCN network for initial review and edits and subsequently made public on the project website, highlighting the environmental, social, and cultural similarities and differences between both regions, as well as needs across the network in terms of data and cyberinfrastructure to enable decision-making on the ground in both regions. These reports will also be expanded into publications to ensure our findings have broad reach in the scientific community.

1.9: Broader Impacts

The proposed RCN has the potential for enormous broader impacts for Indigenous communities in their ability to navigate the rapid social and environmental changes ongoing in both regions. These communities are often underserved and underrepresented in scientific research and are often among the poorest and most food insecure members of their respective regions. Indeed, the recently released

Canadian Food Report Card (2017) found that Nunavut received the lowest grade out of all Canadian provinces and that a quarter of its population faces moderate to severe food insecurity. Similar trends are occurring with Native tribes in the US Southwest. On the GRIC, 40% of households have an income of less than $20,000 per year with 48% of households classified as in poverty (ARPI 2011). The development of the network will create relationships with other communities facing similar challenges and ensure discussion of alternative strategies for food security and resilience in both regions. This network is designed to empower communities to openly discuss these issues and create ideas for future projects and implementation of any discussed outcomes and needs of the communities. Additionally, this proposed network will create a plan for preserving and visualizing IK and connecting it to scientific data. These efforts will ensure that data and information more widely available to a number of different audiences and ensure sovereignty over information for Indigenous communities. Indeed, in a recent briefing of the Arctic Council, a representative from the US Department of State said, "First, we were trying to improve the economic and living conditions of the people who actually reside in the Arctic" and goes on to highlight the need for international and cross-regional collaboration (US State 2017). This project is designed to fulfill these exact goals.

1.10. Results of Previously Funded NSF Research

Strawhacker and Pulsifer: RIDIR: Building Cyberinfrastructure to Enable Interdisciplinary Research on the Long-Term Human Ecodynamics of the North Atlantic. SMA 1439389 and 1637076. Total of two awards: $1,498,640. 2014-2020. **Project Data-** The Digital Archaeological Record. **Project Code –** dataARC Github Page (2017). PI: Strawhacker, Co-PIs: Buckland, Pulsifer, Opitz, Lethbridge, McGovern, and Dawson. Intellectual Merit: The networking of these scholars and organizations offers a unique opportunity to conduct genuinely transformative, collaborative research and cyberinfrastructure development to connect natural science, social science, environmental humanities, IK, innovative data management, visualization, and direct involvement of northern communities (Strawhacker et al. 2015a, b). Broader Impacts: The ultimate goal of this project will be to transform the accessibility and utility of data collected over multiple decades by multiple disciplines, and across hundreds of thousands of square miles. These data will be widely available and shared with researchers and other users internationally.

Pulsifer and Strawhacker: Collaborative Research: ELOKA Phase IV: Optimizing Data Management Support for Community-Based Research and Observations Contributing to Arctic Science. PLR-1513438. Amount: $1,546,176. 2016-2019. PI: Peter Pulsifer Co-PIs: Strawhacker, Gearheard, and Duerr. **Project Data -** Held by ELOKA. **Project Code –** NSIDC GitHub Page. The Exchange for Local Observations and Knowledge of the Arctic (ELOKA) records, preserves, and shares community data and information collected by and with Arctic communities. ELOKA provides core data management services, helps to build local and regional capacity, and is fully enabling interoperability through systems development. Intellectual Merit: ELOKA develops the theoretical and methodological foundations of community data management and knowledge stewardship, makes data available beyond the community of origin, and fills a critical gap in Arctic science by providing support and infrastructure to community-based research. Broader Impacts: Making community data available to support research in a number of areas including social sciences, health research, environmental science, adaptation studies, and others. Also, supports language and cultural preservation and maintenance.

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Note that * marks a result of prior NSF funding to RCN PIs

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Facilities, Equipment, and Other Resources

NSIDC Facilities

The National Snow and Ice Data Center (NSIDC) will serve a major part of the proposed project by providing personnel support and expertise in data management and interdisciplinary research. NSIDC has created projects for the Arctic Social Sciences as well as Arctic Indigenous Communities, and follow the Agile approach to ensure the products meet the needs of the end user. This experience base will ensure the proposed RCN will be successfully completed within the planned time and budget. NSIDC will also provide the majority of experience and guidance on data platforms, cyberinfrastructure, software development, testing and debugging of the developed tools and website. NSIDC is housed in an administrative/research complex on the East Campus of the University of Colorado. Conventional and wireless network services provide connectivity to internal services and to the internet. NSIDC houses two major Information Technology environments, the NSIDC/CU system and the NASA ESDIS Core System (ECS). The Computer center is an award winning "Green" data center that cut cooling energy more than 90% and total energy 70%.

The NSIDC/CU infrastructure provides archive, production, and distribution services to a wide range of data sources: SMAP, IceBridge, IceSat, DMSP SSM/I, NIMBUS, TOVS, and the NSF Advanced Cooperative Arctic Data and Information Service (ACADIS) as well as, value-added data sets generated by a variety of cryospheric researchers. Principal components of the University of Colorado NSIDC infrastructure include:

- 10/1-Gigabit LAN residing in the University of Colorado address space
- A Fully virtualized server environment and as well as bare metal servers totaling over 480 servers
- A 1600 sq ft datacenter with an advanced cooling & solar power system (near 0 carbon footprint)
- Linux servers for core IT functions and MS Windows server for internal administration functions
- Network Attached Storage (NAS) array with solid state cache 200TB capacity
- A redundant array of inexpensive disks (RAID) of 280TB capacity
- Off-site back up servers an a RAID array with 70TB capacity
- Quantum tape backup systems
- A Sungrid engine for parallel processing
- Full development, test and production environments
- Linked to the CU MRI (Janus) supercomputer with 10,000 cores and 1PB of disk storage
- MySQL, PostgreSQL, database servers
- Apache web servers along with Drupal content management systems
- Conversant collaboration tools and Jira tracking tools
- Metadata database and publishing system
- Search and discovery data access systems (Search, Polaris)
- Automated deployment environment with Vagrant and Puppet
- Agile development environment supporting Java, Python, Ruby, Jenkins, GIT
- High speed film scanners, plotters
- Unix, Windows and Mac user platforms
- 2.5 hours of UPS backup
- 50,000 watts of solar power with solar power backup for the cooling system

The NASA EOSDIS Core System (ECS) provides archive and distribution services to data obtained from MODIS, AQUA/AMSR-E, and ICESat/GLAS. Principal components of the ECS include:

- 1-Gigabit LAN residing in NASA address space
- Quantum tape backup with capacity of over 500TB

- StorNext for tape and disk file system management, respectively
- 700 TB disk array providing for on-line data access
- Linux Redhat server and IBM blade server environments
- Sybase Enterprise Server relational database management system
- File-level subsetting services (HEW Subsetting Appliance) developed at the University of Alabama, Huntsville
- Search and order interfaces to the NASA EOS Data Gateway client and the NASA EOS Clearinghouse (ECHO/ Reverb)

The Computer Systems Engineering group and NSIDC are connected together and to the outside world by the University of Colorado LAN and the NSIDC ECS LAN, which are connected to the University of Colorado Campus 10-Gigabit backbone, providing routes to and from NCAR, the Front Range GigaPop, and the Abilene (I2) national backbone.

University of Arizona Facilities

COMPUTERS: All project staff have laptop computers with high-speed internet connections for note-taking and writing. The University of Arizona's Environment and Natural Resources Building 2 has A/V equipment available for use at the workshop.

OFFICES: Full office support including telephone, fax, photocopier, video projection equipment/computer displays, etc. In addition, the University of Arizona's Udall Center for Studies in Public Policy and its Native Nations Institute will provide administrative and financial services support leading up to and after the workshop.

MEETING ROOM

The University of Arizona's Environment and Natural Resources Building 2 room N604 is a modern facility space for the workshop. The room size will accommodate up to 40 participants sitting in a circle and staff, with the ability to break out into smaller groups for discussion. Restrooms, outdoor break space, and office facilities are all in close proximity.

Data Management Plan

While the proposed RCN will not collect any new data, it will result in the creation of new ideas, projects, and potential digital platforms and cyberinfrastructure to be further developed in future funding and project cycles. Concrete planned products include the creation of new networks, the connection of complementary nascent efforts in two regions of the world, a social network to connect our community in between in-person meetings, a project website to store and advertise project outcomes, and direct outreach efforts to ensure that all direct and potential collaborators are included in the conversations of the RCN.

Information Exchange and Materials Sharing: The core RCN team will meet regularly both in person and via online platforms, including teleconferences and a social network to be developed after the first in-person meeting. These venues will provide an excellent opportunity for core partners (all included in the project description, as well as any organizations or individuals who wish to engage as the network develops) to review findings and ongoing reports and publications. As outlined in the project description, the team will also draw upon extensive networks in data and cyberinfrastructure, food security and climate science, and Indigenous Knowledge to ensure that materials reach networks far past the organizations directly affiliated with the project.

Intellectual Property Rights: The intellectual property rights of the outcomes of the project will be a key theme that will be explored throughout the development of the network. Much of the discussion will focus on the ethics and ownership of Indigenous knowledge, data, and information and how this information is best shared. These decisions will be left solely to our Indigenous partners, but in the experience of the PIs, Indigenous communities are often willing to share parts, if not all, of those knowledge and information sources that will be made available online. Often compromises are made – including the development of a use agreement (see ELOKA's SIZONet platform for an example: https://eloka-arctic.org/sizonet) - to ensure that data, information, and observations can be made available with the considerations of the Indigenous community taken into account. Authorship of any papers and reports will be jointly decided by the group, as various products develop. The PI team has extensive experience in multi-authored papers and have negotiated authorship order among teams many times. A potential model may include ELOKA's authorship of white paper and reports with Indigenous partners (seen here: http://www.arcticobservingsummit.org/sites/arcticobservingsummit.org/files/Pulsifer-ELOKA--Extended_Sharing_Knowledge_statement.pdf) in which there is a primary contact person, but the joint authorship and contributions of the network are primary.

ELOKA's Policy on Access and Sharing: ELOKA deals with a wide variety of data including those that fall under the conditions of consent agreements. As is standard ELOKA practice, data are maintained and released in accordance with appropriate standards for protecting privacy and maintaining the confidentiality of respondents. ELOKA operates on the principle that all knowledge should be treated ethically, and intellectual property rights should be respected including the maintenance of rights to ownership, control, access, and possession. At the same time, we strongly promote open exchange wherever possible. The ELOKA team and data management systems have the ability to steward data with access constraints and different rights regimes. We are able to hold or restrict data distribution, as appropriate, to address ethical or proprietary considerations or to an embargo period of exclusive use. All personal data (e.g. signed consent forms, interview transcripts) will be protected and maintained using standard practices supervised by the ELOKA team. Typical methods include making data anonymous through use of an identifier key and securely storing key records separately from data, for example. Paper documents will be digitized and encrypted and the originals stored in the secure analog archive available through ELOKA.

While access constraints will exist, wherever possible open data licensing strategies will be used. Where appropriate, content will be assigned a Creative Commons 0 (CC0), or Attribution Only (CC BY) license. This will maximize the possibilities for sharing data. Any software developed in support of network activities will be released using an open source license. The aforementioned licensing tools and potentially others will be used in continuous consultation with community members.

Data will be shared using ELOKA's current distribution mechanisms including the ELOKA Web site, FTP download packages, Web Services, delivery of physical media (e.g. CD ROM), CBM applications, and use of Web 2.0 tools. Data discovery will be facilitated through the documentation of data using metadata and publication of data in the ELOKA Catalog. As a subset of the NSIDC Catalog, metadata records are propagated to other catalogs such as the Global Change Master Directory and the Arctic Data Explorer through the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH).

ELOKA's Approach to Data Preservation: Data preservation is supported through a multi-faceted approach that starts with adequate documentation of data using metadata and the use of formats appropriate for long-term preservation. Once appropriate metadata are created and any necessary reformatting carried out, data are submitted to the Data Conservancy System hosted on NSIDC infrastructure. NSIDC supports ELOKA using a mix of virtual and physical servers that provide for data management and access. Each virtual and physical machine has fully resilient data storage (expandable as needed) utilizing an enterprise disk array configured with redundant RAID disk; data is made available to servers through a fiber channel Storage Area Network. A periodic backup of the data is created both on- and off-site. On-site backup typically takes place three times per week for both archive and File Transfer Protocol (FTP) data locations. Off-site (internet) backup of the archive and FTP data locations is run periodically as well, but less frequently, with the archive location backed up once a month and the FTP location backed up two times per week.

ELOKA data preservation is now primarily supported through the use of an instance of the Data Conservancy technology stack. This software system will support all key data preservation operations including documentation, ingest, format and media migrations, backup, search, access, user and group management, creation of archival packages, and many others. Additional details about the Data Conservancy software stack and planned developments are included in the Project Description for this proposal.

Given that this proposal has been submitted to the Arctic System Sciences program, any specific scientific datasets created (this is not anticipated) or those discovered that may be of interest to the community will be submitted to the NSF-supported Arctic Data Center. Both Strawhacker and Pulsifer serve on the Scientific Advisory Board for the Arctic Data Center and will coordinate with them closely to deem when this may be appropriate.

The longevity and history of successful data management and cyberinfrastructure development of ELOKA ensures the sustainability of hosting of these materials long after financial support of the award has ended.