NC CSC Adaptation Statement of Work

PIs: Dennis Ojima
Dennis.Ojima@colostate.edu

Shannon McNeeley
shannon.mcneeley@colostate.edu

1. Statement of Problem and Rationale

Severe drought impacts are among the costliest weather and climate disasters in the United States (Smith & Katz, 2013). The 7-state North Central region covered by the NC Climate Science Center has experienced a series of extreme to exceptional droughts in recent years with widespread impacts across sectors. One report on the 2002 drought impacts estimated a loss of $3 billion to the agricultural sector in Nebraska and South Dakota (Hayes, Svoboda, Knutson, & Wilhite, 2004). The Rocky Mountains across the region have experienced forest die back (Allen et al., 2010; Hicke et al., 2012), increased pine bark beetle outbreaks (Hicke et al., 2012; Logan, MacFarlane, & Willcox, 2010), and intensification of forest fires across the northern Rockies.

The objectives for this work will be:
Objective 1: Characterize different resource managers' drought risk perceptions, decisions, and differential adaptive capacities. This objective will focus on natural resource management issues related to DOI, USDA, and tribal managed in the region. This will include the identification of drought-related local indicators and decision timing and spatial scales.
Objective 2: Characterize how drought risk perceptions correspond to climate events in the region. From recent drought events, historical climate trends, scientific drought indicators, and projections will be analyzed to see how they correspond to drought risk perceptions in order to develop and archive site-specific "drought stories."

Within this north central regional domain, the Missouri River Basin is a significant geographic feature and is the largest watershed in the nation, covering over 500,000 square miles, and producing over 40,000,000 acre-feet of water annually (Reclamation, 2011). The basin is home to approximately 12 million people, including 28 Native American tribes. It is an important agricultural production region with livestock being a significant component of the sector. Tribes and rural communities depend on ranching of cattle and bison for cultural and economic importance. The US Department of Interior (DOI) plays multiple roles in ranching livelihoods in the region through Bureau of Land Management (BLM) leasing permits on public lands, the National Park Service (NPS) and US Fish and Wildlife Service management of bison herds, the Bureau of Indian Affairs (BIA) who provides multiple technical and planning services to tribal ranchers, and the Bureau of Reclamation (BOR) (and BIA) who manage reservoirs and stored water releases for agriculture, to name a few. Additionally, the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) provides information and tools for ranch management, and the USDA Forest Service also leases land for livestock grazing. All of these federal agencies operate in shared drought-impacted landscapes that have multiple land ownership and authorities for management.

Drought crosses political boundaries, land ownership, and jurisdictions for managing these shared landscapes and resources e.g., water and wildlife. Severe drought impacts can affect large expanses of landscape containing multiple public and private land owners and multiple jurisdictions, which designate how those land and resources are managed. Drought impacts resulting from a lack of precipitation, increased air temperatures, reduced snow cover, or any combination of these features can cover extensive areas affecting forage production. In addition, local drought impacts can result from prolonged heat stress on animals, which when combined with reduced water availability, are exposed to additional stress and can be more vulnerable under these conditions. The North Central region provides a good example to study the drought impacts and responses across a mix of public and private lands being managed by the Department of Interior management agencies and tribal governments. For instance, the Badlands and surrounding area of southwestern South Dakota contains land managed by the NPS, the USFS National Grasslands, the headquarters of the InterTribal Buffalo Council (ITBC), and two Indian Reservations, with some of the poorest communities in the United States. Ranching of cattle and bison are primary livelihoods in that area of the region and the NPS and tribes manage multiple bison herds. The area also contains the South Unit of Badlands National Park, which is likely going to contain the first Tribal National Park with a proposed additional 1,000 head of bison (http://www.nps.gov/badl/parkmgmt/upload/BADL_SCOPING_NEWSLETTER_SUBR-EA_Spring_2014_PEPC-2.pdf). In Northwest Colorado, where snowpack is abundant in the higher portions of the Yampa-White Basins region, during times of extreme drought there is still limited water both physically and legally available to distribute between agricultural, municipal, energy along with maintaining instream flows (ISF) for the four species of endangered fish in the Yampa River. In the Wind River Indian Reservation (WRIR) in west-central Wyoming the lack of monitoring and a drought management plan for the Eastern Shoshone and Northern Arapaho tribes result in deleterious impacts to the reservation's agricultural production as well as fish and wildlife important to their subsistence and cultural activities. These three examples provide case examples for studying the complex interactions between drought and local/regional conditions.

Drought risk and adaptation are inherently both social and biophysical processes (Glantz, 1994). The NDMC Drought Impacts Reporter, for example, demonstrates that what constitutes a drought is much broader than just the analysis and information provided by scientists on meteorological, hydrological, and numerical economic indicators (Botterill & Cockfield, 2013). The social implications and manifestations of drought impacts and responses are complex, multi-faceted problems that are still not well understood or documented relative to other natural hazards (D A Wilhite, Svoboda, & Hayes, 2007; Donald A Wilhite, 2005). They are even less well understood in the management of public lands within the DOI and local tribes. While progress has occurred for assisting ranchers with drought preparedness and management through various incentive programs and tools, additional work is needed to localize drought monitoring information and accurate climate outlooks for local- and regional-level planning and for providing easy and usable access to information and tools (Knutson & Haigh, 2013). Very little is empirically documented to date on the DOI management role for both using drought knowledge for their own management activities as well as how they can facilitate drought management for private ranchers and tribes. Some initial insights from the DRAI interviews follow. Effective land and resource management in multi-jurisdictional landscapes requires good relationships and knowledge between both public and private managers. Part of the challenge is a high turnover of managers in tribes and DOI field offices. In addition, there is a need for a systematized way to understand and document drought at scales that are meaningful to managers across jurisdictions. Without a systems view and a longer term perspective, new managers have no reference point for putting their specific drought impacts into the longer-term context. This project aims to bridge that gap.

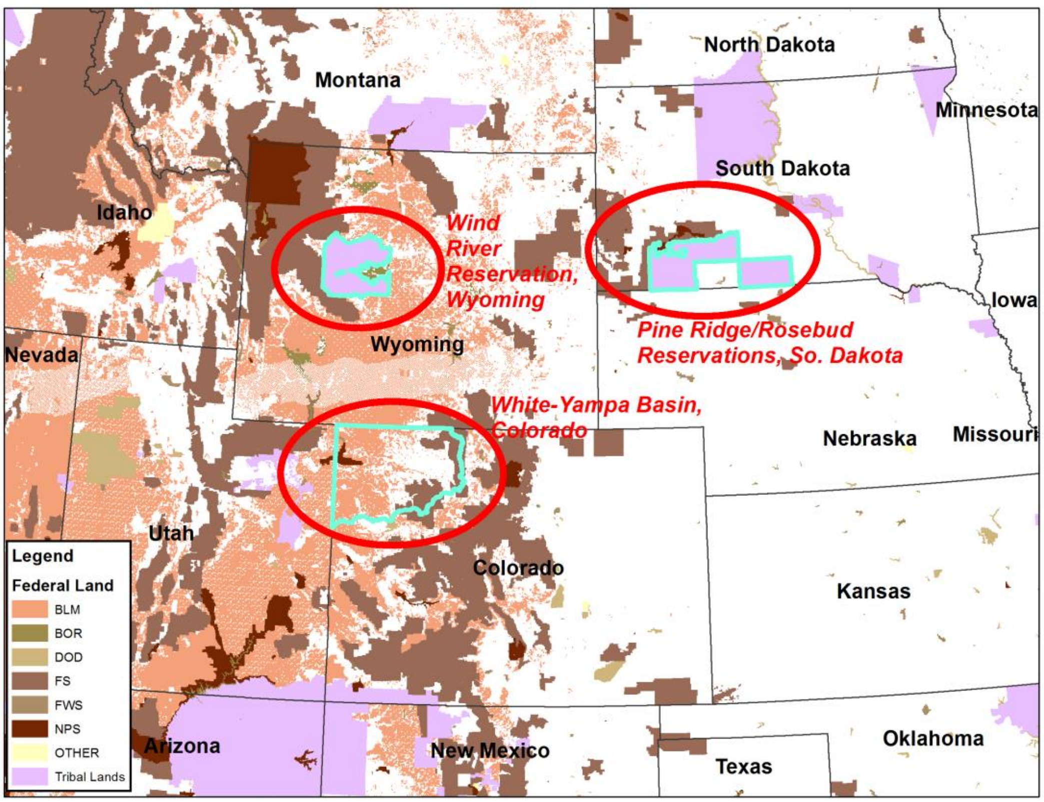
The purpose of this research is to understand how different federal and tribal natural resource managers experience and deal with drought in cross-jurisdictional landscapes that contain public and private operations on or near DOI, USDA/US Forest Service, and/or tribal lands in the region. The goal of this proposed project is to develop a better understanding of both drought social-ecological system (SES) vulnerabilities, risks, and responses in high-risk, multi-jurisdictional landscapes across the North Central domain, extending from the Rocky Mountains into the Great Plains. Our research poses the following questions: How do different resource managers from the Department of Interior (DOI), other federal agencies, and tribal communities perceive and characterize drought risk in the same geographic area? How are their respective grassland/rangeland, fish and wildlife, and forest management decisions affected by those drought risk perceptions? What are their differential capacities for responding to and preparing for drought risks? To investigate these questions, we will: 1) document local DOI/tribal resource managers' risk perceptions of drought impacts of various land and resource management activities in across a variety of management targets over the domain, 2) characterize how those risk perceptions and responses correspond with or differ from each other and with scientific drought indicators, and 3) identify respective decision calendars and the appropriate temporal/spatial scales for climate information needs in order to provide rigorous, localized drought science and tools to managers.

2. Scientific Objectives

The Adaptation team will continue to lead the Drought Risk and Adaptation in the Interior (DRAI) project that began in 2013. The overarching goal of this project is to learn more about how drought will affect federal and tribal land management social-ecological systems and how these effects are incorporated into decisions made by natural resource managers across different agencies and jurisdictions in shared landscapes throughout the Missouri River Basin. The research employs an iterative, interdisciplinary Social-ecological Systems (SES) approach, to include the utilization of drought indicators with natural resource managers and conducting key stakeholder interviews and workshops. The information gained from these interviews and workshops provides additional input based on local knowledge and observations about drought impacts to develop relevant climate information on droughts. Initial, exploratory interviews were conducted in 2013 in two of the 3 landscapes mentioned above (SW South Dakota and NW Colorado) to begin to develop a shared methodology, test questions, and perform initial analyses on the interview data (interview questions in Appendix A). Additional interviews will be conducted on the Wind River Indian Reservation that began in September 2014. The continued building and refinement of the SES DRAI database will continue and will inform and guide the climate and ecosystems analyses on drought indicators described herein. This will, in turn, help the objective for climate scientists to better understand how to frame their climate analysis and outcomes to make them more useful and usable to different natural resource managers operating in shared landscapes. This is consistent with the goals of the NC CSC and the U.S. Department of Agriculture (USDA) climate hubs to provide managers and other decision makers with the most salient, relevant, and legitimate climate research to support land and resource management decisions.

Public lands resource managers, ranchers, and tribes represent a diversity of cultures and communities that differentially perceive drought on their landscapes. Managers in the region have an objective to prepare for future drought and climate change, which will require strategies for collective resource management (W N Adger, Arnell, & Tompkins, 2005). With the goal of integrating the understanding of risk perceptions and drought indicators across jurisdictions in the region, two scientific objectives guide the proposed interdisciplinary research on drought. Lead by the work of the Adaptation team, the foundational teams will also collaborate on three specific drought-theme cases. These locations for these cases are chosen based on the work of the adaptation and vulnerability team in the DRAI assessments:

- Northwest Colorado DRAI study area
- SW South Dakota DRAI study area
- Wind River Indian Reservation, Wyoming DRAI study area



Objective 1: Characterize different resource managers' drought risk perceptions, decisions, and differential adaptive capacities. This objective will focus on natural resource management issues related to DOI, USDA, and tribal managed in the region. This will include the identification of drought-related local indicators and decision timing and spatial scales.

Objective 2: Characterize how drought risk perceptions correspond to climate events in the region. From recent drought events, historical climate trends, scientific drought indicators, and projections will be analyzed to see how they correspond to drought risk perceptions in order to develop and archive site-specific "drought stories."

3. Research Plan and Proposed Methodology: Integrated Social-ecological systems (SES) methodology to understand drought risk and responses

An integrated social-ecological systems (SES) scientific approach to climate change and drought risk and adaptive capacity assessments ask who, what, where, how, and when "on the ground" was affected by a particular climate stressor (James D Ford & Smit, 2004; Barry Smit, Burton, Klein, & Wandel, 2000). The integrated approach described here is used by climate change social scientists for examining climate variability and change vulnerability as framed by exposure (climate stressors), sensitivity (a system's or population's susceptibility to harm), and adaptive capacity (potential to respond to or prepare for climate stress) (N. Adger et al., 2007; McNeeley & Shulski, 2011; Polsky, Neff, & Yarnal, 2007; Turner et al., 2003). This approach is increasingly used to analyze the social-ecological dimensions of drought risk (Engle, 2012; Fontaine & Steinemann, 2009; Kallis, 2008; McNeeley, 2014).

Conventional scientific assessments of climate risks are formulated as a function of probability, severity, and outcomes. However, the social science of risk and risk management elucidate a much broader set of complex and nuanced variables as critical to understanding how people both perceive and respond to risks (Renn, 2011; Verweij et al., 2006). This calls for the integration of concepts and tools for analysis that can empirically document the full spectrum of risk from the biophysical to the social (Tschakert, 2007). Risk and adaptation to environmental change also cross scales of time and space. Climate adaptation, for example, occurs at the scale of the individual or household (Grothmann & Patt, 2005) to societal scales of corporations, cities, tribes, states, and nations (Bierbaum et al., 2013; Vincent, 2007). Capacity to respond to drought and other climate stressors can also be limited by social, political, and regulatory barriers, which are important to understand for building capacity and actually implementing adaptation plans and strategies (W Neil Adger et al., 2009; Bierbaum et al., 2013; Ekstrom S.C. Moser, and M. Torn, 2011; McNeeley, 2012)

The focus of this project is on local- to regional-scale drought risk and responses, which necessitates an approach and methods to gain an understanding of resource managers' risk perceptions, local observations of drought impacts, response capacities, and barriers to respond. While it is a common misconception that everyone perceives drought in the same way as "abnormally dry," a deeper SES understanding reveals that different people define and understand drought and drought risks in very different ways. Therefore, this approach does not determine adaptive capacities *a priori*, but rather, with the stakeholders themselves (B Smit & Wandel, 2006). This requires empirically documenting and analyzing these aspects of decision making through interviews with the managers and analysis of those interviews alongside drought indicators to get a full picture of drought risk. NCCSC Adaptation track co-lead McNeeley implemented this approach working with tribes in Alaska and found that the approach elucidated nuances of local biophysical and social experience that were masked by conventional statistical analysis of trends (McNeeley & Shulski, 2011). The combined and iterative approach led to outcomes that are specific to local impacts and responses. For this proposed project, questions asked will be about the local and other indicators used to understand drought in their landscapes and decision calendars, and coping and adaptive capacities to both respond to and prepare for future extreme drought. The methodology is outlined below in "steps," but because this is an iterative process (and is based on the co-PIs' past experience using this methodology), we know that some of these steps will overlap as this is not a purely linear approach.

Research Methods: Interdisciplinary social-ecological-climate systems approach to reviewing relevant scientific and grey literature; conducting interviews with resource managers; and analyzing both differences and similarities of risk perceptions, decisions, and capacities across jurisdictions.
Research Methods: Compare and contrast different risk perceptions, drought indicators, and related data compiled from Scientific Objective 1 with analysis of relevant climate and drought data and indicators.

Step 1: Manager Interviews

The first step is to conduct directed and/or semi-directed interviews with federal and tribal land managers, agricultural stakeholders, and other key management stakeholders in high drought-risk landscapes. Interviews will be conducted through a combination of phone and in-person meetings with managers. We will identify the appropriate managers to interview within DOI, USDA/USFS, and tribal offices that have some decision-making role in managing grasslands/rangelands/livestock, fish and wildlife, and water resources. The identification of interviewees will occur through the contacts already made in the DRAI exploratory interviews, through agency websites, and through contacting supervisory staff to help identify the best people in their agencies/offices to interview on the topic. We will also use forums such as the NIDIS Missouri River Basin Drought Early Warning System (DEWS) pilot, the regional Landscape Conservation Cooperatives (GNLCC, PPPLCC, SRLCC, GRLCC), and other related mechanisms to find other key informants. As mentioned above, exploratory interviews were already conducted in 2013 in South Dakota and Colorado, and additional interviews will be conducted in the Wind River Reservation and the other two case sites, as necessary.

In addition to interviews, we will observe and document the aforementioned relevant meetings and workshops (including web-based "virtual" meetings and webinars) related to the topic in the region of interest. Participating in relevant regional stakeholder meetings adds deeper context and understanding of key stakeholder interactions and decision-making processes as well as nodes and networks of information that add depth to the analysis.

Data collected through the literature, interviews, and other stakeholder meetings and workshops will be analyzed via qualitative and quantitative data analysis using Atlas.ti[1] analytical software and a grounded theory approach. Atlas.ti is a powerful tool for organizing and coding qualitative and narrative data to create nominal variables that can then be queried and geo-coded for analyzing the patterns among and linkages between those variables (Hwang, 2008; Lewis, 2004).

[1] http://www.atlasti.com/index.htm

For this project, we will use the tool to identify similarities and differences in risk perceptions, use of local knowledge and observations and scientific drought indicators, decision calendars, adaptive capacities and responses. This analysis will also help elucidate nodes and networks of information flow that will help identify "leverage points" for how this proposed project (and the NIDIS MRB DEWS pilot) can contribute to better-informed decisions related to drought.

This research utilizes a determinants approach to understanding socio-natural drought risks, which includes the understanding of processes that underpin or determine adaptive capacity (J D Ford et al., 2010; Fussel & Klein, 2006; Grothmann & Patt, 2005). General determinants and types of climate adaptation decisions are used to develop questionnaires and coding protocols; however, those that are context-specific are derived from the data itself (Barry Smit & Skinner, 2002). Analysis of interview data will be performed using a modified Grounded Theory Approach to identify the determinants of adaptive capacity (Bryant, 2002; Charmaz & Bryant, 2010; Mills, Bonner, & Francis, 2006). This approach provides structure to the analysis, while at the same time leaving enough flexibility for inductive reasoning based on the data itself. Here we use this "bottom up" approach to the first phase of a climate vulnerability and adaptation assessment, which establishes current and baseline vulnerability, adaptive capacities, and responses to date with the stakeholders themselves (B Smit & Wandel, 2006).

Additional stakeholder engagement will gather more data as needed (e.g., possible focus groups and/or additional interviews or surveying as determined by the evolution and refinement of the project) and will also provide a mechanism for the iterative dialog and feedback on the interim results and analysis to guide subsequent steps of the research. The results of this analysis will underpin the specific direction for Steps 2 and 3 outlined below toward the creation of regional and site-specific "drought stories."

Step 2: Historical drought trends and future projections

Insights gained from the analysis results of Step 1 will be used to interrogate the data on climate and drought historical trends in the region, and to create "drought stories" that include the mosaic of drought risk perceptions, decisions, adaptive capacities, historical climate trends, and climate projections related to drought in the region. Seasonal timing of impacts along with decision calendars and local drought indicators will be used to identify the most important data sets, the parameters of analysis, and the time and spatial scale of that analysis. Data from the High Plains Regional Climate Center will be used to analyze historical and context-relevant precipitation data (total precipitation, departure from normal, and percentage of normal) and temperature data (temperature maximum and minimum trends, departure from normal), based on interview findings, to create regional storylines for historical trends that are place- and decision-context specific. This piece of the analysis will provide the basic climatological history for temperature and precipitation trends in the region of interest to compare with the interviews and other climate analyses looking at the drought indicators and projections described below.

The newly launched NDMC Drought Risk Atlas will be utilized for the drought-indicator analysis along with weekly calculations of multiple indices. The Drought Risk Atlas brings precise climatological data down to spatial scales that allows scientists and decision makers to use this tool to better understand drought in their respective region and to make better-informed decisions. The purpose of the new national Drought Risk Atlas was to expand the data in both the number of stations analyzed and the period of record to include the most complete long-term stations. Using a weekly time-step to calculate multiple drought indices at each station location, rather than on a climate division scale, allows for a more spatially-precise representation of drought histories. The Standardized Precipitation Index (SPI), Standardized Precipitation-Evapotranspiration Index (SPEI), Palmer Drought Severity Index (PDSI), the United States Drought Monitor, and other climatological data are included in the new drought atlas. The project team will work to use the atlas to localize these data at the appropriate temporal and spatial scales for the land and resource units, management decisions, and needs as identified through interviews with managers. Because the focus is on grasslands/rangelands, we will also use VegDRI as it integrates satellite-based observations of vegetation conditions, climate data, and other biophysical information such as land cover/land use type, soil characteristics, and ecological setting, which can also be useful to managers in this context.

To complete the "drought stories" we will include projections of future drought. The NC CSC is in the early stage of conducting a drought-climate analysis across the central and northern Great Plains. As a part of this effort, region-specific drought-climate information is now being compiled by the NC CSC. Historic drought trends analysis may be augmented with gridded data DAYMET and PRISM, and climate derivatives, such as potential evapotranspiration, soil moisture levels, and heat indices for various thresholds for plants and livestock, as they are ready and relevant to the other research findings in this study. The NC CSC drought-climate analysis will also investigate drought in climate projections from the Coupled Model Intercomparison Project phases 3 and 5 (CMIP3 and CMIP5) and in downscaled data derived from these climate projections. The CMIP3 projections were analyzed and reported on in the IPCC Fourth Assessment Report (AR-4) and the US National Climate Assessment, and CMIP5 projections were used in the recently released IPCC AR-5.

As University Director of the NC CSC, Dr. Ojima will oversee this phase with the new lead for the NC CSC climate science foundational area, NOAA CIRES (Cooperative Institute for Research in Environmental Sciences) for atmospheric scientist, Dr. Joseph Barsugli, and a post-doctoral fellow that is being hired by NC CSC, to provide a suite of climate projections to support the development of projected drought stories for this study, and to identify the relevant model outcomes as they are developed in the upcoming year for inclusion into this project. Although the choice of projections and datasets is not complete, it is anticipated that projections of drought indicators from the SRES A2, RCP 8.5 and RCP 6.0 emissions scenarios will be developed, using an ensemble approach to characterize uncertainty. Downscaled datasets at the USGS GeoDataPortal, and from the NASA NEX project will be readily available for evaluation and analysis. Dr. Barsugli is a climate theory and modeling expert who has a long history of working at the interface between climate science and stakeholder needs through his work with the NOAA RISA Western Water Assessment at the University of Colorado, Boulder. He is part of the broader NC CSC team and will provide support for projects such as this one as part of his new role as climate science lead. We will also work to utilize and build on the NOAA NESDIS Great Plains regional climate technical reports for the National Climate Assessment so as to avoid duplication through the alignment with other existing NOAA climate modeling efforts.

Step 3: Decision support tool development

The results from the social and climate analysis will be integrated using a Geographic Information System that uses tools to combine various types or "layers" of complex quantitative and qualitative data for geographically-specific analysis and visualization. GIS mapping provides powerful tools for integrating and displaying data sets for both conducting the integrated analysis as well as communicating results with stakeholders. The NC CSC has GIS technical staff that can support data integration for visualizing the drought stories with ESRI ArcGIS mapping software.

In addition, through localizing NDMC data and tools for DOI and tribal managers, such as the Drought Risk Atlas activity described above, and through customizing the Drought Impacts Reporter to create place-specific drought stories, the results from the social and climate analyses will be used to create site-specific regional "drought stories" for scientists and managers to use. These stories will include a tailored compilation of the interview highlights, drought maps, indices, and (where appropriate) projections for their region. The NDMC team will assist the project team to tailor several NDMC tools, such as the U.S. Drought Monitor, the Drought Impact Reporter, the Drought Risk Atlas, and the Vegetation Drought Response Index. The HPRCC team will tailor regional seasonal outlooks for the managers. Tribal student fellows will work with the research team to customize these tools to their respective tribal landscapes, and will help to make them both culturally-appropriate and usable for their tribal managers. Students will be selected through partnerships with tribal leaders and project collaborators.

4. Integration

For this type of SES integration work, challenges exist in such a distributed institution with PIs and other researchers at various institutions throughout the north central region. This challenge is magnified when the foundational science leads were not included in the proposal development from the beginning in the case of solicited projects. In order to do relevant science that will be good for the science or relevant to the "on the ground" reality, there has to be an iterative process between the various scientists and managers using a combination of face-to-face meetings and information and communication technology. For the SES integration to work any project requires at least:

1. The right people – a team of people with a shared vision and the right areas of expertise (in our case for adaptation, a team with *at least* one scientist who is an expert on this type of climate-related SES integrated work, and the others to "get it" and be willing to stretch their comfort zone and actually *listen* and *value* the social science expertise)
2. A shared conceptual and analytical framework or set of frameworks
3. A process for regular, frequent, consistent, and well-documented discussions on the science and the integration, both in-person and in writing
4. No egos and no "gate keeping" of stakeholders, whose input is absolutely critical to SES integration work

The three foundational science teams will build in a process that will incorporate these criteria to work toward effective integration (see section on "Collaboration Strategies"). This will include a process whereby the insights that are gained through the continuous analysis and updating of the

DRAI project will inform how we as a collective identify problems and analyze and synthesis the data in meaningful ways to managers that can help inform their ability to respond to and prepare for drought, as well as inform their climate change adaptation efforts. Integration and collaboration between the social science, climate, and ecology provides a deeper understanding of the complexity involved in managing for natural resources under climate change combined with other non-climatic drivers of change (Jasanoff, 2010).

Connection to USDA Hub and NOAA NIDIS and NDMC in the region

The NC CSC is currently working with NOAA/NIDIS on the development of the MRB pilot project by supporting the organization and planning of the 2014 MRB NIDIS kickoff meeting. The evolution of this pilot effort will directly inform the ongoing refinement of the development and course of the project proposed herein. This project will be a collaborative effort between the NC CSC, the proposed Northern Plains USDA Regional Climate Hub, the NOAA Central Region Climate Services, National Drought Mitigation Center, NOAA High Plains Regional Climate Center, and the new NIDIS Missouri Basin pilot to develop a more comprehensive understanding of social-ecological drought risks and responses of DOI and tribal grasslands and livestock systems through various sub-regions of the MRB. The NC CSC is fortunate to have the Univ. of Nebraska-Lincoln as part of its university consortium where both the NDMC and HPRCC are located. Additional NOAA SARP funding for this project will facilitate strengthening those ties through the activities of the NIDIS pilot, and help with research to close information gaps that was so important for the success of other NIDIS pilots such as the Upper Colorado River pilot. We will work in close collaboration with the leads of the NIDIS Missouri Basin pilot development to provide interdisciplinary research capacity and tools to inform the science and the decision support tools for early warning and adaptation with key DOI, tribal, and related stakeholders in the basin, outlined in Section 2. This will help with both the development of, and will bring additional users to the NIDIS drought.gov portal.
List of project deliverables:

1. Series of GIS maps integrating data from interviews, climate, and ecosystem analyses that visualize the “drought stories.”
2. Web-based pages that have “drought stories” that will include a combination of the map outputs above, other audio-visual materials, and linked the UNL NDMC Drought Impacts Reporter
3. Scientific publications on results in peer-reviewed journals
4. Annual reports
5. Other tailored materials for and co-produced with agency and tribal scientists and managers

Work Plan and Schedule of Activities

	Year 1		Year 2		Year 3	
Task	Q1-Q2	Q3-Q4	Q1-Q2	Q3-Q4	Q1-Q2	Q3-Q4
Continue analysis of DRAI interviews in CO and SD	■	■				
Interviews with water managers in Wind River Reservation	■					
Attend DRAI relevant meetings, workshops, webinars	■	■	■	■	■	■
Summarize findings from DRAI interviews on drought indicators		■	■	■		
Geocoding and GIS mapping of management decisions	■	■	■			
Coding of Wind River Reservation interviews		■	■	■		
Analysis on Wind River Reservation Interviews			■	■	■	
Interviews in South Platte Basin				■	■	
Coding of South Platte Basin Interviews			■	■		
Analysis of South Platte Basin Interviews				■	■	
Ground truthing of drought indicators	■		■		■	■
Meetings with foundational science team leads for integration for "drought stories"	■		■		■	■
Workshops with managers on results				■	■	■
Summarize all results in usable formats for scientists and managers	■	■	■	■	■	■

Appendix A: DRAI Interviews

1) How do you define or think about drought in the context of your landscape?

2) Do you view drought as a significant risk to your management activities?

3) [if yes to #2] At what time of year is drought most problematic (how/why) [this is getting at seasonality/timing issues)?

4) What year (or years) was the worst drought in this area? What happened?

5) What management decisions do you have to make that are affected by drought?

6) a. What, if any, indicators do you use to know if/when/how drought is going to cause negative impacts on your landscape?
   b. What do you consider to be the best source or sources of information on drought?

7) Are there fish, wildlife, and/or plant species you haven't mentioned impacted by drought in your landscape?

8) a. Are there human livelihoods or other activities impacted by drought in your landscape?

   b. Does this cause any conflicts?
   c.Do you collaborate with other stakeholders or jurisdictions on drought-related issues? If so, with whom and how?

9) Do you have the capacity to either respond to or prepare for drought?

10) Are there barriers that inhibit your ability to respond to or prepare for drought?

11) Anything else we haven't discussed?

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