South Central Climate Science Center Science Workshop

Fort Worth, TX: November 29-30, 2012

The Department of Interior's South Central Climate Science Center (SC-CSC) invited federal and university researchers and land management representatives to participate in a science workshop on November 29-30, 2012 in Fort Worth, Texas. The workshop was intended to provide an opportunity to identify near- and longer-term, high-priority SC-CSC research topics in preparation for the USGS proposal solicitation that was released on January 7, 2013 as well as for pursuing supplementary external sources of funding in the South Central United States.

The South Central region exists in a zone of dramatic transition both in terms of eco-climate system diversity and in terms of occurrence of extreme events. The South Central Climate Science Center provides scientific information, tools, and techniques that land, water, wildlife and cultural resource managers, and other interested parties in Oklahoma, New Mexico, Texas, and surrounding areas can apply to anticipate, monitor, and adapt to climate and ecologically driven responses at regional-to-local scales. The workshop also helped introduce researchers to the needs of land managers and began a dialogue on conducting stakeholder driven science.

The over-arching theme that threaded through each breakout session of the workshop was "Precipitation Variability."

The three specific breakout session topics were:

Regional Physical Climate Variability and Trends

Katharine Hayhoe (Texas Tech University) and Kevin Robbins (Louisiana State University)

Overview

In this session we discussed aspects of regional physical climate variability and trends focusing on three topic areas: (1) *drivers of regional climate variability and change, (2) data and model output,* and *(3) data provision to stakeholders*. The session was primarily attended by climate modelers, data providers, practitioners who use climate data in a variety of ways, and program administrators and managers. The discussions were lively, engaging nearly all of the attendees who brought unique perspectives to the conversations. The first day was dedicated to identifying and discussing topical issues, while the second day focused on conceptualizing potential collaborative projects that would advance the capabilities of the SC-CSC in the area of regional physical climate science, data, and modeling. Six projects were identified and prioritized in terms of relevance, importance, and level of effort required (i.e., low, medium or high-hanging fruit). These six projects, described at the end of this report, all require considerable collaboration between institutions, regions, and disciplines. Although not all the expertise required was in attendance, we are confident that the expertise exists across our institutions and welcome any colleagues interested in engaging in these projects.

Topic A: Drivers of regional climate variability and change

In this session we discussed how to comprehensively assess strengths, weakness, and uncertainties associated with our understanding of the drivers of regional physical climate variability and trends in the South Central region. Discussion incorporated observations, modeling and methods/techniques as well as relevance to SC CSC stakeholders.

What is known about climate drivers?

- Stakeholders are interested in information over both short-term and long-term time scales; for example, crop insurance and land management issues require information from years to a decade; land management planning requires information over longer time scales.
- **Large-scale natural** climate drivers include ENSO and other modes of Pacific-based variability such as PNA (especially in winter and spring, more strongly in the western and southern parts of the region), and the North Atlantic Subtropical High (NASH) and other natural modes of variability over the Atlantic (especially in summer and fall)
- **Regional-scale natural** climate features Gulf of Mexico flow and moisture, monsoonal seasonal circulation, low-level jets, and orography. A persistent dryline in central Texas drives convective precipitation, the region exhibits a strong east-west precipitation gradient, and there are many severe convective and other weather events in the SC region.
- Important **human-based** climate drivers include emissions of greenhouse gases and other radiatively-active species from human activities; local and regional

emissions of aerosols and air pollutants; land cover, land use change, and cultivation methods; etc.
- Regional precipitation patterns are the most important regional climate issue in the South Central Plains and the one that is the most difficult to effectively characterize and model. Studies show that local process drive regional precipitation patterns during much of the year, but smaller scales create more *noise* in the climate signals, so understanding natural variation becomes more important.

Major unknowns

- How water and moisture moves through the climate system in the South Central region, including convective precipitation and how it is parameterized by global and downscaling models; evaporation from surface water and land; influence of climate variability on ground water and runoff (has this changed in recent decades?); etc.
- The impact of policy on water resources, including state water laws
- Stakeholder-relevant information, including extreme precipitation events
- What information is needed by application models in terms of climate variables, description or assessment of uncertainty, and need for specific data and model output formats

Origin of unknowns and uncertainties

- GCMs vary in their ability to characterize large-scale processes important in the SC region. The use of model suites can, at least, indicate a range of uncertainty.
- Understanding of regional scale variation is important in downscaling
- Land surface modeling is an important feedback to physical climate processes
- Ecosystem variation is also important
- We need a better understanding of water budget processes in the region
    - East-west precipitation gradient is huge
    - Shifting this gradient region will cause major shifts in regional hydrology
    - Regional recharge and runoff shifts can be expected to occur
    - Timing of seasonal patterns of rainfall is variable and can be expected to change in future climate scenarios
    - Modification of tropical cyclone activity (a major source of seasonal rainfall) can be expected to change but is not well modeled in current GCMs
    - New Mexico ecosystems are dependent on capturing winter snowmelt and temperature and capture of snowmelt is subject to alteration

How can we improve current understanding of the physical climate?

- Evaluate global model ability to simulate key large-scale features and their impact on our region: NASH, ENSO, PNA, etc..
- Improve surface observations, currently inadequate to characterize regional variability.
    - How do we extend rainfall records at a station to an adjacent area?
    - Oklahoma mesonet would be a good test bed for exploring variability
    - Radar data should be used more effectively to supplement precipitation estimates for model development
    - PRISM datasets (analysis) should be used more

- ORNL DAYMET data (gridded daily surface data) is a promising resource of daily data needed in assessment and models (http://daymet.ornl.gov/)
- Use of integrated monitoring (river discharge, reservoir stage, ground water level) could help us to better understand regional water balance
  - Use GCM output as input to regional hydrologic modeling
  - Look at different downscaling results in terms of water budget
  - Assess changes and impact of the strong east-west gradient region
- Regional aquifers are an important source of water. As levels drop, surface water and reservoirs become more important.
- Reservoirs levels have not been predicted very well in recent years. What's happening? How can we help understand this impact? Is (potential and/or actual) regional evaporation changing?
- Examination of the recent changes in climate patterns can help us understand the range of future variability
- Examination of model sensitivity to changing patterns of precipitation, temperature, evaporation, etc. (overall water balance of region)
- Rapidly expanding regional population may be a major source of unexpected water balance issues
- Reservoirs are a key component of regional water balance. More effort needs to be placed on this component
- What are the major climatological storm tracks (and synoptic causes) across the region?
  - Are these changing?
  - Need further understanding of synoptic pattern influences (NAO, AO, ENSO interactions) on regional precipitation patterns.
- The Deep South has been having serious issues with precipitation. Don't forget about this area and the major population centers (Houston, New Orleans).
  - Precipitation reduction causes saltwater influx to regional water supplies and effects municipal water supply, agricultural yield reduction (rice), and ecological damage in estuaries and marshes.

What regional impact activities are being done within our partnership?

- Nocturnal convection research
- Mangrove migration in the GOM and bird migration across the region
- Reservoir management product development

What projects in the physical climate area can be conducted in support of SC CSC objectives?

- How well is convective precipitation being handled when global models are subjected to downscaling?
- How do regional rainfall patterns in the last 10-15 years compare to long-term historical patterns?
- How do regional patterns respond to statistical modeling? How are the *tails* of the precipitation distributions recreated in downscaling?
- How do wells and reservoirs compare to precipitation changes?

- What is the quality of the well water data record? Reservoirs?
- Make data available to researchers, stakeholders?

Topic B: Data and Model Output

This section had the mandate of *developing a methodology for cataloguing high-resolution regional climate data (both observational and modeled) that is already available and also currently under development for the South Central region*.

This session met with mixed success. We discussed cataloging available data, global model output, and high-resolution projections from downscaling. We also had a long discussion on our inability to determine the needs of stakeholders outside of the climate community. What do they need in terms of variable, temporal and geospatial resolution, data quality assessment, output data formats, etc.? We also tried to assess our role of the SC CSC as information-providers versus researchers.

We concluded that much of our confusion could be handled by a comprehensive data management plan for the SC CSC. A comprehensive plan should address (at least) the following components:

- What is the *role and scope* of the SC CSC in providing or brokering information for:
    - The modeling community
    - The climate data assessment community
    - Other communities such as ecologists, land-use managers, and others
    - The media and general public
- Should we provide data archive information or metadata describing availability and location of data resources?
- If we provide data, should it be as a locally managed data archive, a linkage (portal) to distributed resources available from modelers and data managers, a listing of data resources in order to facilitate access by others, or nothing at all?
- What is the responsibility (if any) to ensure that research conducted under the SC CSC research umbrella use high quality, consistent, comparable, and appropriate climate data and model output?
- Can we improve productivity of research efforts of non-climate scientists by facilitating access to data?
- How do we merge the needs above with DOI requirements to archive and provide access to CSC results?
- If we provide climate data and model output, do we also need to add value to these data by providing *data-products* that subset, format, and analyze these data?

A formal data management plan would go a long way towards providing research and development direction to climate information providers, GCM model developer (agencies), and developers of high-resolution climate projections. Perhaps a data management plan could be a discussion item at the upcoming meeting of the Steering Committee on Jan 22, 2013. Guidelines for data management plans can be found at: https://nccwsc.usgs.gov/content/data-policies-and-guidance .

One thing that we could agree on is that we need to engage non-climate scientists of the SC CSC to assess their need for climate information to perform their research. It was suggested, and strongly endorsed, that there is a need to survey stakeholders and participants to determine these needs. A good start would be to utilize existing information

obtained by organizations such as the Southern Climate Impacts Planning Program (SCIPP) that has obtained information about needs for extreme weather information and climate change perceptions. Interesting results have been obtained during interactions with GOM coastal populations that have identified data and data-product needs that were unanticipated.

Topic C: Data provision to stakeholders

The charge in this session was to *establish variables and timescales of interest to stakeholders and identify ways to determine and communicate level of confidence for existing matching parameters in the catalogue of data.*

How are our stakeholders and how do we engage them?

- Academic and government scientists; engineers; State agencies; Parks Service, Forest Service; U.S. Fish and Wildlife Service; NOAA Coastal (Marine fisheries group); NOAA Sea Grant; Army Corp of Engineers, others
- Make data and climate scenarios readily available
- Emphasize climate *variability* and change to the conservative SC region
- Educate stakeholders on the need to consider multiple realizations of climate scenarios
- Understand our capabilities to provide usable information
- Engage stakeholders, directly, to cultivate a culture of trust; get people excited and involved in what we can offer; attend stakeholder conferences; reach out to them rather that wait for them to come to us
- Use surveys to obtain what stakeholders need from us; use examples and case studies to give them an idea about what we can provide

What can we offer as data and information providers?

- Datasets (surface climate)
  GHCN, COOP, ASOS, CRN, METAR, RAWS, SNOTEL, C-Man, offshore Buoys, State and regional mesonets, others
- USGS hydrological networks: http://waterdata.usgs.gov ; stream flow, groundwater level, well data, precipitation, water quality
- Reservoir data: many separate sources; SRCC and SCIPP are creating a system to integrate reservoir and surface climate information and produce data-products
- Downscaled GCM data! SCIPP surveys and engagement shows that people (especially along the coast) are becoming receptive to planning for future climate impacts.
- We can develop best practices documents to guide stakeholders in the appropriate use of climate data, projections, and downscaling

Final Discussion: Potential Projects

The session ended with a discussion of collaborative projects that might address the issues raised during the discussion above. Primary among our conclusions was that a survey of stakeholders would be essential to informing development of data resources for impact assessments. However, in the mean time we believe that these 6 areas of research would provide useful and fruitful information.

1. **Understanding large-scale climate drivers**. Explore the connection between large-scale (synoptic) atmospheric drivers of (meso to micro scale) precipitation and surface water in the South Central Region and use this information to refine future climate projections in terms of identifying models able to reproduce these features and understanding how they might be affected by global change. This is a relatively small level of effort that could build on existing information, expertise, and analysis.
2. **Plug'n'play climate data and projections**. Produce plug-in observation and climate projections for impact modeling and assessment (a multi-sectoral, SC version of World Clim) to facilitate use of and consistency of projections for non-climate scientists. Collecting the information to provide is a relatively small level of effort, but figuring out how to provide it (including caveating uncertainty, etc.) is not.
3. **Following the uncertainty trail.** We do not yet know what is the biggest source of uncertainty in assessing impacts. For this reason we propose to explore the impact of scenarios, climate models, downscaling methods, and impact models on projected impacts to identify which source of information currently contributes the largest uncertainty. This is a moderate level of effort that could build on existing efforts and expertise.
4. **Understanding the water budget.** There was general agreement that the water budget of this region is one of the least well understood and most important characteristics of this region. For that reason, we propose an analysis of the response of the surface water budget (runoff) to the past 50 years of historical climate variability. This is a high level of effort, but one that will provide essential information to understanding the impacts of climate variability and change on our region.
5. **Regional climate response to global change.** There are many unique aspects of regional climate that could respond differently to global change and are also important to impacts. A few examples include: when will summer arrive and how long will it last? Will ice storms become more common? Will the severe weather season shift and/or extend throughout the year? Will the characteristic split flow patterns that bring precipitation to this area be affected? For that reason we propose a project to study what drives regional seasonality and how might it be affected by climate change. This could lead to more informed downscaling and high-resolution modeling efforts that would in turn improve the quality of regional climate projections. This is a high level of effort, but one that would yield valuable understanding of the interaction between global and regional change and its effects on impact-relevant climate characteristics.
6. **Improving quality and quantity of observational data.** There are many sources of data that could be improved and mined to derive impact-relevant products. One example that was brought up was synthesizing radar and weather station data to quantify very high resolution (inter-station) precipitation variability, of interest to urban areas to assess flood risk. Another was quality-controlling existing data to

improve confidence and reduce uncertainty. A third idea was to identify observing equipment or locations that could easily and affordably be fixed or upgraded so as not to lose a long data record (e.g. stream gauges). A fourth was to enhance existing networks such as the TX/OK Mesonet. Depending on the scope of the project, this could range from small to large levels of effort, but as the focus would be on providing improved quality and quantity of observational data to the region, the investment would be well spent.

Ecosystems and Landscapes

Keith Owens (Oklahoma State University) and Paul Risser (University of Oklahoma)

Introduction

Among the purposes of the South-Central Climate Science Center workshop were to build regional research capacity focused on climate-related issues, to expand interdisciplinary research and to work cooperatively and strategically across multiple institutions. To meet these purposes, the Ecosystems and Landscapes working group addressed the following five topics:

1. Regional classification systems
2. Drivers of ecosystem and landscape change
3. Research data management
4. Ecosystem/landscape and social science integration
5. Initial interdisciplinary research priorities

Regional classification systems

At the national scale there are numerous landscape classification systems including, for example, those for vegetation, land cover/land-use, hydrologic units and stream systems. Moreover, there have been several attempts at the federal level to agree on a multipurpose classification system. However, no generalized classification system exists that satisfies the needs of all agencies and purposes.

Having an agreed-upon ecosystem/landscape classification for the South-Central Climate Science Center region would be particularly useful for several reasons:

- Serve as a common framework for aligning studies and for reconciling data originating from multiple projects
- Offering a common framework for presenting results from across the region
- Providing consistency with the USGS and other agencies, allowing the appropriate extrapolation and application of research results

Both the US EPA ecoregions and the USGS classifications are useful for the Climate Science Center, and all other considerations aside, should serve as the basic classification system. However, ultimately the science question driving the project, the utility and application of the results, the characteristics of the available data and correct resolution of results all drive the decision about the most appropriate classification system to be used for each study.

Several considerations are important as decisions are made about the selections of classification systems:

- Consistency with the EPA and USGS systems, or other classification systems used in the Center
- Richness of the data that are or could be aligned with the system
- Scale of the collected data and its analysis, interpretation and application

- Completeness of coverage within the South Central region, and extension into adjacent regions as appropriate
- Usefulness by LCCs and other management organizations for the currently targeted and subsequent purposes.

As the Climate Science Center achieves greater experience, the classification question should be periodically reviewed to determine if one or more of the classification systems could more strongly become the *de facto* choice.

Drivers of ecosystem and landscape change

At the general level of understanding, many of the drivers of changes in regional ecosystems and landscapes are known based on past responses. However, in many cases, the responses are not known at an adequate level of accuracy and precision, the future responses are not necessarily predicted from the past based on changing conditions, and the interactions among drivers and responses are difficult to test and are not well known.

Important drivers of climate/land-use and land-management changes include, for example, variables encompassed in the energy-water nexus, changes in human populations and urbanization, agriculture practices as well as more broad scale processes such as N deposition. Clarifying these drivers then becomes key in designing research studies and data analyses, constructing monitoring systems, conducting risk analyses, and communicating and applying results for characterizing ecosystems and landscapes and in guiding land management.

In creating research projects and building research capacity within the Climate Science Center, several observations about drivers of ecosystem and landscape change are useful.

- Drivers are frequently connected with many different targets, including for example, ecosystem processes, watershed dynamics, and special species.
- In using measurement to characterize both the dynamics of drivers and the resulting responses, patterns and deviations (particularly extremes) are frequently more informational than means.
- As ecosystems and landscapes are driven to change, they do so at different rates. In some cases the responses change significantly, moving to a quite different state or behavior. These thresholds are very important in both understanding the structure and function of ecosystems and landscapes, and in predicting the impacts of these changes on their production and resiliency capabilities and for deciding on management strategies.
- For purposes of both science and management, it is fundamental to understand the mechanisms of drivers, and how they might change over time and space. Thus, in many cases mechanistic models are more useful than statistical ones.
- Research priorities within the region involve not only understanding the drivers of ecosystems and landscapes, but there is an equal need to identify and understand key drivers of relevant and management systems.

- In testing and interpreting the ecosystem and landscape driver-response dynamics, the spatial and temporal scales of drivers must be reconciled with the scale of responses.
- Depending on the research or management question being addressed, the effects of drivers are likely to occur at multiple and complex space and time scales, and at different levels of strength.

As the Climate Science Center expands its research agenda and works closely with land and resource managers, the portfolio of known relationships between drivers and ecosystem and landscape responses will grow rapidly.

Research Data Management

One of the great strengths of the Climate Science Center is its ability to accumulate data from multiple sources and institutions, and from many disciplines, and then to aggregate the data and information on a regional basis. As a result, the intellectual capital of the Center will theoretically increase over time. However, realizing this continual increase in data and knowledge (measures of intellectual capital) will require a robust and responsive data management system.

While the South Central region will ultimately be responsible for managing its data, the network of Climate Science Centers also has a role to ensure that there are no unnecessary duplications, that data are managed conveniently and efficiently, that intellectual property issues are satisfactorily addressed, that workable policies are in place, that resources are shared in the most cost-effective ways, and that all the eight regions are fully involved in the planning and execution of the data management and supporting cyberinfrastructure.

Because the region will have specific data management requirements and opportunities, the ultimate data system will be a hybrid of existing capabilities from many sources combined with Climate Science Centers as a whole and specific mechanisms in South Central region. There are several important points that should guide the construction of the data system.

- Whenever possible, the region should seek to benefit from existing policies, mechanisms and infrastructure. For example, the Long-Term Ecological Research program has more than three decades of experience addressing very closely related issues, and the emerging National Ecological Observation Network (NEON) is building a nationwide sensor network of great relevance to the Climate Science Centers.
- The completeness and accuracy of metadata will be paramount in the Climate Science Center, especially as the program includes many researchers, disciplines and institutions over long periods of time.
- The NSF-sponsored DataONE project is well along in building a network of ecological data repositories that is supported by a variety of software tools. One of its primary goals is to provide a mechanism enabling ecological research data from individual studies to be known and available. In addition, DataONE has created tools for ensuring high-quality metadata and for redundant storing of data and metadata.

Among the recommendations for Climate Science Center data management are the following.

- Recognize and make provision for historical as well as current data.
- Stipulate that data will be made publicly available as soon as it has experienced the QC/QA steps (perhaps 18 months after collection).
- Consider becoming a DataONE member node.
- Explore the opportunities to create common data templates to increase the quality of metadata and to facilitate the sharing of data.
- Consider if there are models (e.g., SWAT, PRMS) that, all other considerations aside, should be encouraged to maximize transferability of research results and ease of application throughout the region.

It is important to recognize and plan for the entire suite of data management processes, including data storage and mining, analysis and assimilation, models and visualization.

Ecosystem/landscape and social science integration

As a research enterprise dedicated to providing science for improving the management of natural resources, the Climate Science Center is inextricably connected to humans and the social sciences. These multiple connections include, for example, human participation in research, assessment of human goals for natural resource management and creating natural resource characteristics sought by humans. Thus, the Center should fully incorporate and integrate the social sciences into its research programs.

Among the considerations in this integration are the following.

- A key step in the process of each project, and the planning of the Climate Science Center's research agenda, is the systematic identification of the proper suite stakeholders (users, partners).
- Like ecosystems, different human populations require different approaches and processes.
- It is important to work with stakeholders to optimize communication mechanisms for framing questions effectively, clarifying information needs, and for identifying data and information transfer preferences.
- In terms of the above point, ecosystem/landscape researchers and social science experts should collaboratively develop a conceptual framework for maximizing two-way communication with LCCs and with other stakeholders. In planning these two-way communication processes, there are significant opportunities to use a much wider array of communication tools, such as infomercials, population-specific influential personalities and models of many types.
- A primary focus of the Climate Science Center program should include using social science expertise to develop and implement effective decision support tools associated with the research program.
- It is possible to design ecosystem and landscape research to incorporate a component aimed at maximizing the probability that the research results will be assimilated into the human decision-making processes.

- As these human-coupled science studies develop, there are further opportunities to create more effective approaches through which scientists can provide research-based information within the Climate Science Center research domain.

Initial interdisciplinary research priorities

Potential high-priority research projects have been identified by the USGS through a comprehensive process with LCCs and other agencies. In addition, the South-Central Climate Science Center conducted a number of rollout sessions throughout the region, resulting in a number of additional research priorities. These enumerations will provide the basis for the selection of high-priority ecosystem and landscape projects.

In developing the Center's research agenda and priorities, the following recommendations will be useful.

- Use a watershed orientation with a focus on integrating instream flow, using multiple inputs and outputs, data collection mechanisms, analyses and models.
- Co-locate monitoring stations, including for example, ecological and social science measurements aligned with Mesonet networks.
- Decide when and if there is value in focusing on one watershed such as the Red River as a common watershed for study, or if it will be more productive to identify a separate set of watersheds designed to test a range of scientific challenges using an experimental network of reference watersheds and those with distinctive impacts.

Among the strategic considerations for the Climate Science Center is whether to focus its human and financial resources on several different independent projects, or to direct the Center's combined interdisciplinary expertise toward one significant research topic, problem or region.

Human Dimensions

Alicia Knoedler (University of Oklahoma)

Executive Summary

The workshop in Fort Worth was the first time this group had assembled to discuss areas of interest in social, behavior, economic, and communication sciences (human dimensions) in the context of the South Central Climate Science Center (SC CSC). Although the topic of human dimensions was mentioned during the development of the SC CSC, the grand challenges and research questions of interest in this area had yet to be defined. Given that this was the first time for investigators to come together to discuss their mutual interests, the breakout sessions were focused on the opportunity to get to know one another and learn about strengths, interests, and discuss potential future collaborations.

After discussing various areas of interest (see the notes below – they are quite varied), the Human Dimensions group joined the Ecosystems and Landscapes group to have a joint discussion. Of importance to the Human Dimensions participants was to make the point that research questions need to be formed at the intersection of the disciplines, including social, behavior, economic, and communication sciences, rather than treating the "social sciences" as a service component, token piece, or as an add on. Most investigators seem to be in agreement that collaboratively-created (across all the relevant disciplines) research questions is the best way to proceed, it was not resolved as to how best to do this. In the context of the SC CSC, it is expected that this structure will be helpful in connecting investigators across disciplines.

Day 2 within the Human Dimensions group was focused on discussing the areas of interest and how, even among members of the group, we need to define some terms, understand successful examples of how various disciplines can work together, and find some time to understand various theoretical frameworks to guide future idea development. The group was unanimous in asking for a listserv to facilitate continued discussions and Dr. Knoedler agreed to facilitate additional discussions as needed.

Interested faculty/stakeholders in joining the listserv should contact Aparna Bamzai (aparna@ou.edu).

Original Goal

The Human Dimensions Section had the challenge of mapping the appropriate kinds of social science research into the problem of precipitation variability. It also had the opportunity to take stock of the kinds of research foci and capabilities available among social science collaborators within the SC CSC. The original goals was for the discussion to lead to a series of specific social science research initiative proposals, or White Papers, of direct relevance to precipitation variability within the region.

Setting the Context

Other topics were presented and discussed:

- The history and context of human dimensions research in the SC CSC
- Our potential strengths including social science research in the SC CSC relative to other CSCs (most of which have discussed social sciences but perhaps not defined their strengths
- Disciplinary blinders – challenges and opportunities to understand perspectives that cross disciplinary boundaries; defining joint language and tacit knowledge
- Marketing challenge – learning to be realistic in "marketing" strengths, not over selling but helping others to learn to define questions and communicate potential outcomes relevant to stakeholders; helping other investigators to not see the social, behavioral, economic and communication sciences as an add-on or something to be considered just as a component of "outreach".
- Varied audiences (e.g., legislators, policymakers, landowners, etc.) and expectations from the human dimensions group – other disciplinary areas may expect that the human dimensions group will do most of the work and communicating with stakeholders. The challenge is to define joint research questions across the disciplines.
- Funding trends – many agencies (USGS, USDA, EPA, NSF, etc.) are increasingly interested in social and behavioral sciences and many more funding opportunities have been issued in the last 2-3 years. The time is right for investigators to pursue these funding opportunities whenever possible.

Overarching Theme:

- Precipitation Variability – How do we define this in the context of human dimensions? The example that was given as lacking: "Ability to understand and describe the impact of sea level rise on coastal communities, their perceived risk and resulting individual and group actions."
- USGS Priority Areas (handout)
- Generalities used to inform decision makers (knowledge of decision making is relevant here)
- Adaptation advice – things are changing but what do we do about it?
- Describing and reducing uncertainties
- Building research and knowledge transfer capacity

Charge to the SC CSC Group:

- Developing tools to help landscape managers make decisions (knowledge transfer)
- Develop research questions to pursue collaborative funding opportunities
- Work across disciplines and interests
- Need to learn management and coordination
- Leveraging and capacity building (national network and larger enterprise)
- Clear goals and deliverables

Action Items for entire SC CSC:

- Identify and prioritize research questions related to the 3 topical areas for the next 0-5 years
- Articulate your level of interest in addressing some of these questions and who may be on the research team, esp. interdisciplinary teams
- Identify funding opportunities and lead investigators
- List barriers to addressing these questions and how the CSC can catalyze research

Challenges and Opportunities for Human Dimensions:

- What are your biases and the biases of others?
- Keep the interdisciplinary vision in mind
- Communication to other groups - multilingualism
- Getting to know the LCC coordinators
- Avoiding the "service bias" and tokenism
- Consider the academic scholarship and the management significance
- Deliverables

Getting to Know the Group

Because this area was not included in significant detail within the SC CSC proposal, it was important to define the research strengths and interests across the participants prior to tackling the problem of precipitation variability or defining white papers. A document describing the research interests and other points that participants wanted to voice in the context of the discussion and the broader goals of the SC CSC was generated for internal group use.

Time was dedicated at the outset of the breakout sessions to help everyone get to know one another. The following questions were posed and each participant was asked to briefly answer each:

- Who are you?
- Where are you?
- What are your immediate research interests and goals within your research program?
- Challenges within your research program?
- What will you bring to this discussion?
- Within the overarching theme, what are your research questions of interest?
- What kind of collaborator are you?
- What is your experience with making your research relevant to multiple audiences?

The last 5 questions are important to aid the group in understanding participant perspectives, especially as they relate to working together as a group.

Outcomes from the Getting to Know You session:

- Overall – we weren't as brief as we need to be; we need to work on messaging
- There seem to be many in the group who want to study an issue vs. others who just want it solved (this issue is a barrier, how do we remove):

    - Scaling
    - Systems
    - Communicating across diverse audiences
    - Collaboration effectiveness
- Strong interests in:
    - How to communicate
    - How to organize
    - How to digest information and make it relevant
- Some Strengths:
    - Networks and Connections
    - Willingness to collaborate
    - Making individual research relevant
    - Data sets and mechanisms for collecting new data

Discussion of Areas and Interests among the participants

We spent part of Day 1 and Day 2 discussing areas of interests among the participants of the Human Dimensions group (an idea sandbox session). At 3:45 on Day 1, we joined the Ecosystems and Landscapes breakout group to have a joint discussion. Summary points of each of these discussions are below.

Idea Sandbox Summary

- Group expertise/interest is strong in:
    - Decision science
    - Tribal/indigenous populations
    - Intersection of water/watershed and human dimensions
    - Communication
- Key discussion points:
    - Demographics of target populations include not just land managers but landowners who have differing priorities and values, particularly when it comes to wildfire issues.
    - Communication could go beyond education to actually convince and induce action – is this the responsibility of the SC CSC?
    - Need to establish operational definitions at level of stakeholders.
    - Need to better understand the needs and questions of LCCs.
    - "Value" of water is both economic and sociocultural. Defining "value" is important.
    - Social science disciplines are different – can they work together in the context of the CSC?
    - How do we describe different social, economic sciences (aren't they all the same)?

Ecosystems and Human Dimensions Discussion Summary

- Can research questions be reconsidered or re-conceptualized to include both social and

ecosystem sciences?
- Social sciences need to be brought in as an intellectual partner and contributor at the very beginning of projects.
- Significant need to define uncertainties AND how to adapt to them.
- Translational issues need to be worked out, including "uncertainty" and even within this group, what constitutes "tools" for decision support?
- Should we focus on advocacy or education or neither within the SC CSC?

Where does the expertise lie within the Human Dimensions group?
- Knowledge about what people value and why
- Knowledge of how science impacts policy making and public opinion
- Knowledge of how to translate science into useable information
- Knowledge of bureaucracy and the connection between information and policy change
- Strong knowledge of and interest in coupled human-natural systems
- Human migration
- Rural farming and climate stress
- Infrastructure vulnerability
- Water scarcity
- Water policy
- Collaborations among indigenous and scientific communities
- Collaborations among scientists and managers
- Communication, including risk and crises
- Risk perception
- How populations process information
- Decision making
- Economic impacts of climate change on agriculture
- Climate and health
- Land use change choices in response to climate and hydrologic stress
- Land management
- Conservation concerns and practices
- Networks – organizational and academic
- Social movements and organizations
- Statistical and modeling skills
- Youth participation
- Marginalized populations
- Science literacy and translation

What are the next steps?
- Creating a new tacit knowledge together
    - While tacit knowledge appears to be simple, it has far reaching consequences and is not widely understood
    - Annotate the knowledge that we have

- Strong desire to maintain an open dialogue
    - Don't wait for the RFPs to continue your discussions
    - Reach beyond your disciplines to find others to define and refine your research questions (esp. bridging the natural and social sciences)
    - Developing tools to help LCC coordinators and managers make decisions (knowledge transfer) – they need to answer the question, "So What?"
    - Leveraging and capacity building (national network and larger enterprise)
    - We will set up a listserv for future discussions and possibly have facilitated online discussions to keep interest in the group going.

More specific points made during discussions

Are there appropriate frameworks (e.g., coupled human and natural systems) that exist or can be developed for examining the impacts of climate change on human populations on a regional scale?

- Analytic Deliberative Model
- Coupled Human Natural Systems
- Others…

Summarize research efforts undertaken so far in the South Central region, including traditional populations and those especially vulnerable to climate change such as Native American, coastal, low-income, etc. communities.

- Trust
- Leadership
- Establishing Credibility
- Confirmation bias
- Demonstration projects
- Factors that affect how one accepts a science-driven message
- Translating the science
- Adaptation and vulnerability assessments

Resources/tools participants would like to see:

- Research and data sets available electronically
- List of relevant resources, publications, etc.
- List of Research Questions from the LCCs and make that list available across the SC CSC.
- List of funding opportunities with a means for interested SC CSC members to declare their interest or intent to submit
- Set of short and long term goals

Some of the questions and issues of interest:

- Market values/economic concerns and the understanding of how humans value services and determine what they are willing to pay for.

- Knowledge about how information is consumed could inform research questions – how do we get this knowledge out in the open to get this process started? Do we have individuals in the CSC who can provide this knowledge?
- Does advocacy lower the credibility of science? What about actionable science (which is more than education but stops short of advocacy)?
- We might benefit from a description of the science -> social science -> management continuum. The continuum flows both ways and the methodology, data acquisition, and format need to be considered from the outset.
- How can we think about our stakeholders (need to have a multidimensional definition of value)? How do we provide not only scientific data but also recommendations in a form that can be effectively communicated?
- What happens when the data suggest a change that will be very hard to accept among the humans who own or manage the land (communication, advocacy/outreach/intervention, are we not having the conversation with landowners because managers presume recommendations for change won't be accepted?)
- Human dimensions as a measurement problem; what measures aren't part of the decision tools but could be?
- Humans and the ecology/environment/etc. have been disassociated in our conversation but from a tribal perspective, these things are tightly coupled – the language and descriptions that we have been using are foreign to someone who has this perspective.
- Need to deal with defining the terms "vulnerable", "marginalized" – the definitions change with the context; scientific models can inform these definitions via what the data indicates. Perhaps the definitions need to come from the populations themselves – leave the labels behind and see whether some of the data indicates the need for categorizing
- What is a model of integration that brings the right people to the table and translating the science? How can we be relevant at the landscape level to help people prepare and provide guidance? Some people seek out science to make informed decisions and others definitely do not.
- How can we incorporate the best science and perception together but not constrain the science? How does the social science perspective help us frame the natural systems questions? Can we "do science differently" in order to increase the probability that the results will be assimilated and accepted?