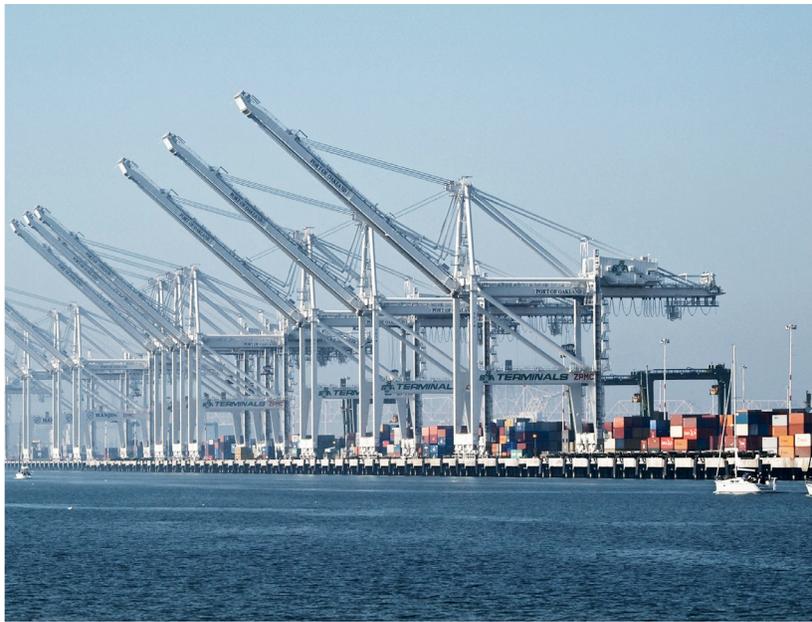# NOAA WESTERN REGION

CLIMATE SERVICE PROVIDERS DATABASE DEVELOPMENT AND PRELIMINARY ANALYSIS

Alison Meadow

Elizabeth McNie

John Berggren

Rachel Norton

Ben McMahan

Gigi Owen

Lynn Rae

NOAA Western Region
Climate Service Providers
Database Development and Preliminary Analysis

Western Water Assessment
Cooperative Institute for Research in Environmental Sciences
University of Colorado Boulder

Alison Meadow
University of Arizona

Elizabeth McNie
University of Colorado, Boulder

John Berggren
University of Colorado, Boulder

Rachel Norton
University of Colorado, Denver

Ben McMahan
University of Arizona
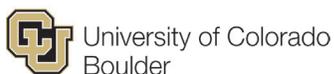
Gigi Owen
University of Arizona

Lynn Rae
University of Arizona

Design and Layout: Ami Nacu-Schmidt

Cover Photos

Colorado River: Wikimedia Commons, Alex Proimos
Port of Oakland, California: Wikimedia Commons, Ingrid Taylar
Lake Powell, Utah: Wikimedia Commons, PRA
Oregon coastline, Ecola State Park: Wikimedia Commons, Cacophony

TABLE OF CONTENTS

ACRONYMS

AMS	American Meteorology Society
BOR	Bureau of Reclamation
CPO	Climate Program Office
CS	Climate Services
CSC	Climate Science Center
DOI	Department of Interior
GAO	Government Accountability Office
GFCS	Global Framework for Climate Services
IPCC	Intergovernmental Panel on Climate Change
IOOS	Integrated Ocean Observing System
LCC	Landscape Conservation Cooperative
NCA	National Climate Assessment
NCEI	National Center for Environmental Information
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Survey
OAR	Office of Atmospheric Research
RISA	Regional Integrated Sciences and Assessments
USGS	United States Geological Survey
USFWS	United States Fish and Wildlife Service
WGII	Working Group II
WRCC	Western Regional Climate Center
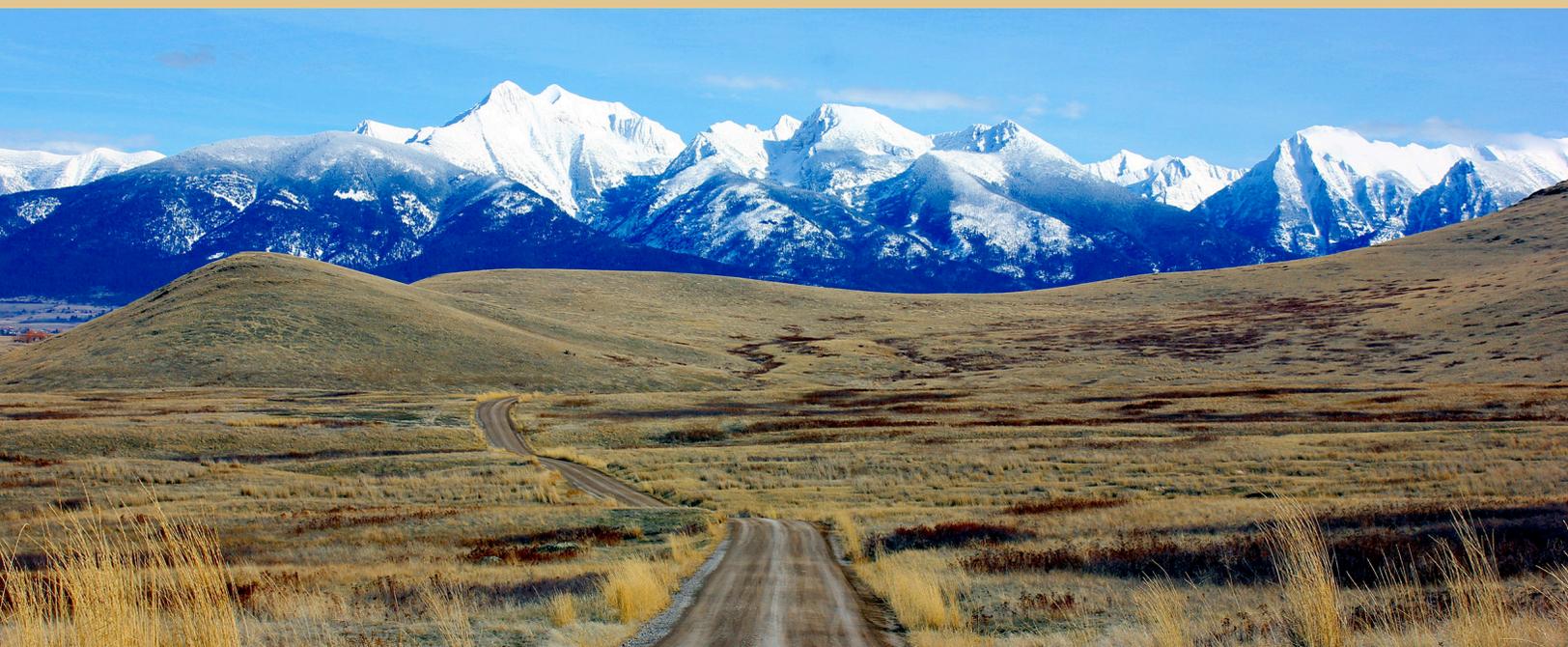
The Mission Mountains seen from the National Bison Range, Montana. Photo: Wikimedia Commons, Jaix Chaix.

BACKGROUND AND AIM OF THIS DOCUMENT

Climate variability and change is causing perturbations to natural systems (agriculture, water regimes, forestry, ecosystems, coasts and oceans, temperature extremes, etc.) and human systems necessitating that communities, states, and nations around the world take action to enhance their resilience to climate impacts (Melillo et al. 2014). Adapting to climate change requires decision makers to have information in hand that is relevant to solve their problems, that is, information that is salient, credible, and legitimate. Decision makers do not often have the information they need to make decisions. Perhaps they are unaware of existing useful information, get too much of the wrong kind of information, or have information needs that go unmet, leaving them to muddle through important decisions that could help people adapt to climate variability and change (McNie 2007). Hundreds of organizations have been created or evolved to help create, translate, and disseminate potentially useful climate information. Such "climate service organizations" exist in both public and private domains, at research universities and private organizations, and represent a wide variety of sectors. Unfortunately, potential users of climate information often do not know where to look for relevant information, nor are producers of climate information well-connected to potential users, resulting in a gap that separates the supply and demand of climate information (Brasseur and Gallardo 2016). The research efforts in this project represent a first attempt to reduce this gap by creating a comprehensive database of climate service providers in the western United States.

The NOAA Western Region Collaboration Team (NOAA West) is a collaborative body representing the mission interests of NOAA's six line offices in the eleven states of the Western U.S. (http://www.regions. noaa.gov/western). As part of its responsibility, the team works to address regional challenges by connecting people and resources to better understand regional impacts from changing climate conditions through cross-NOAA and regional partner information exchanges and interdisciplinary collaborations.

Every NOAA mission line is involved in climate-related work, but at a different point along the continuum from research to applications. In 2015, as part of its annual budget formulation process, the team focused on ways it could, in close coordination with NOAA's Regional Climate Services Director and in-region partner network, work to advance climate services in the region in order to better address some of the persistent or newly emerging issues facing the region. The team realized that the regional landscape of climate issues, interested parties, partners, and stakeholders was complex, and growing more complex. There was very little systematically collected information on the provision and use of

climate services within the region, and no clear understanding of gaps in information needs, or overlap in service delivery within the region. In response, the team scoped and invested in a project to develop a relational database tool capable of generating information on climate services within the western region. The goal of the project is to inform NOAA and its extensive partner network of the current landscape of climate service provision in the region across specific provider and user groups, and sectors served. This information will help inform NOAA climate service engagement and investment, and help identify gaps in service provision or areas of overlap. This project was refined and implemented by an interdisciplinary team of investigators from the Western Water Assessment (WWA) and the Climate Assessment for the Southwest (CLIMAS) Regional Integrated Sciences and Assessments (RISA) program. The database tool will operationally reside with the Western Regional Climate Center (WRCC).

The aim of this document is to provide information on the NOAA Western Region Climate Service Providers Database (WRCS Database) Development project and preliminary analyses of findings and gaps. Recommendations for "next steps" are also included.

DEFINING CLIMATE SERVICES

Climate services (CS) have been defined in slightly different ways by several different entities. The definitions all share the idea that information about climate (long-term weather conditions and trends over an area or region) can enable communities' adaptation to and reduce their risk from the impacts of climate variability and change. However, definitions vary in terms of the degree to which they focus on the role of the end-user of the information in the process of developing and delivering the information. The World Meteorological Organization, in its Global Framework for Climate Services (GFCS), defines the practice as providing climate information in a way that assists decision making by individuals and organizations. They note that such services require appropriate engagement, effective access mechanisms, and must respond to users' needs (GFCS 2012). In a recent report recommending improvements to the ways in which climate information is currently developed, managed, and delivered in the U.S., the Government Accountability Office (GAO) uses the term "climate information system" instead of CS, defining it as a systematic approach for coordinating the development, archiving, and use of such climate information by decision makers, with specific roles for federal agencies and nonfederal entities (U.S. Government Accountability Office 2015). In an analysis of the German Climate Service Center, climate services are defined as "user driven development and provision of knowledge for understanding the climate, climate change and its impacts, as well as guidance in its use to researchers and decision makers in policy and business" (Manez et al. 2013, 7). Miles et al. (2006, 19618) proposed a similar model for a U.S. climate service describing the ideal entity as resting on the three legs of observations, modeling, and research; but functioning within a "user-centric orientation in which stakeholders are seen as a continuously involved constituency." Another U.S.-based organization, the American Meteorological Society (AMS), defines CS as scientifically based information and products that enhance users' knowledge and understanding about the impacts of climate on their decisions and actions.

Vaughan and Dessai (2014) provide an important point of clarification by differentiating between CS and climate research. *Climate research* aims to further our understanding of the climate system, while CS focus on user needs and application of climate research. The GAO (2015) study noted that, in fact, often no new climate research is required to meet the climate information needs of decision makers – the tailoring and interpreting of that information is more valuable to users (see also Guido et al. 2013).

In this project, we began with the AMS definition of CS. Notably, this definition, unlike several above, does not include the process of delivering information and products. This is an important distinction in the way that CS are defined and undertaken. We will address the implication of simply providing information versus the process of providing CS in greater detail below, but we note here that defining CS in this broad manner allowed us to include climate service providers who simply serve data along with those who focus on the process of tailoring that data to meet specific needs; our database is larger due to this broader definition.
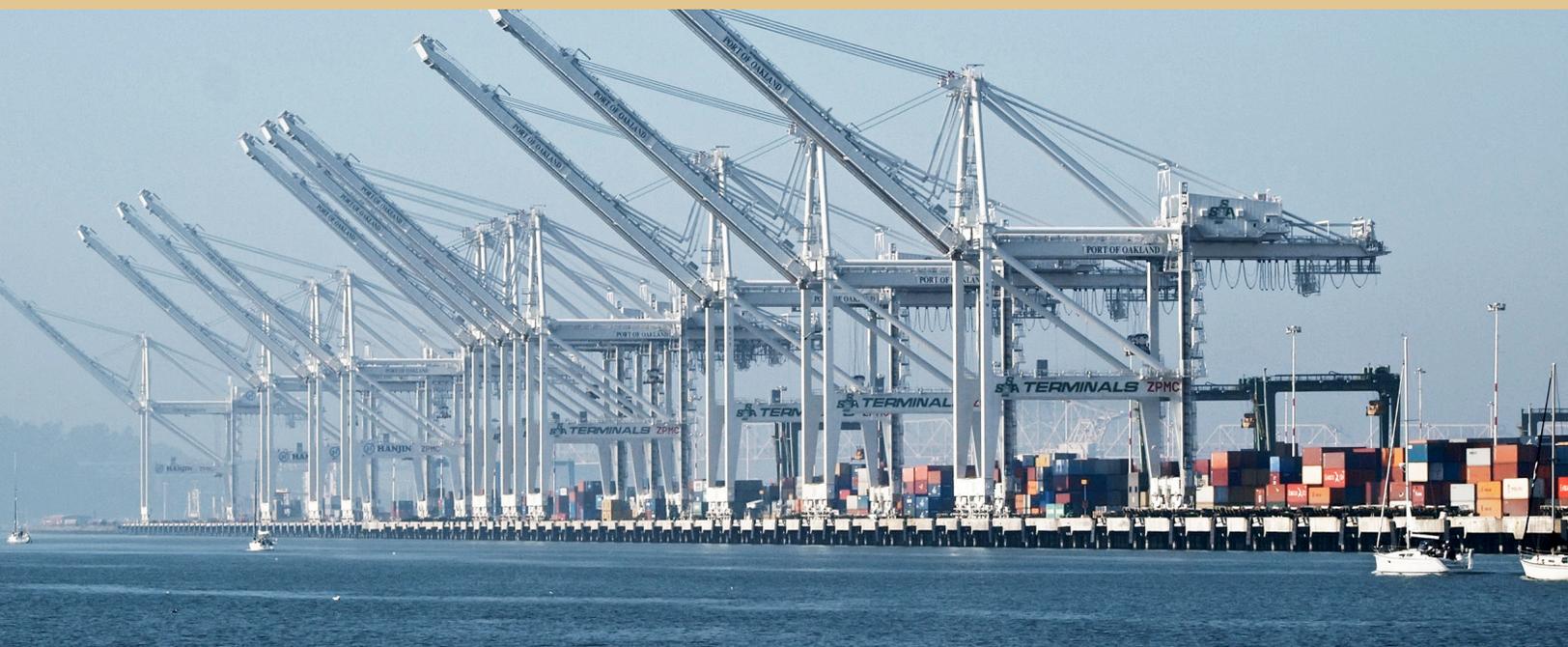
Shipping Cranes in the Port of Oakland, California. Photo: Wikimedia Commons, Ingrid Taylar.

DELIVERING CLIMATE SERVICES

Several authors have discussed the challenges in the process of moving climate research and information into the hands of users in useful and usable formats. Vaughan and Dessai (2014) note that connections between providers and users are often weak and that providers do not always understand the contexts in which decisions are being made. Similarly, Srinivasan et al. (2011, 6) note that, "climate information should be a function of the user rather than the technology used to produce it." They go on to identify five gaps or challenges in the provision of climate information for community-level risk management and adaptation: 1) a mismatch between the temporal and spatial scales of information and decisions, 2) an absence of mechanisms that involve users in identifying their climate information needs, 3) forecasters and other scientists lack expertise in communicating with users, particularly about probabilistic science information, 4) weak communication channels between producers and users, and 5) users often lack mechanisms for processing the information once it is received. Dilling and Lemos (2011) point to the need for iteration between users and producers as a key element in the successful provision of usable climate information. In the context of disaster management, Coughlan de Perez and Mason (2014) suggest five principles to ensure the usefulness of climate information: 1) prioritize immediate user needs, 2) provide only information that is relevant to the user context, 3) provide decision support (information relevant to actions), 4) right scale rather than downscale, and 5) maintain ownership and partnership in design of products. McNie (2013) points to larger issues such as policies that favor basic research and power differences between scientists and information users as factors that inhibit both the necessary connections between climate information producers and users and the provision of usable information. In their study of CS providers and users, the GAO (2015) found that user needs are not being met because current efforts are too fragmented and uncoordinated, federal information providers do not know what information decision makers want, decision makers do not know what is available, and users cannot access the help they needed to interpret the information that is available.

These disconnects and power differences are part of the motivation behind an effort by Adams et al. (2015) to develop a cohesive framework to govern the development and application of CS. They note that negative consequences can arise when CS should be used and are not, and/or from the deployment of such services in ways that bias an outcome. Their concern reminds us that CS involves a process of discovering how the information will need to be used to be effective – and the importance of undertaking the process of tailoring that information conscientiously and effectively. Adams et al. (2015) suggest

that four essential elements of an "ethical climate service" are integrity, transparency, humility, and collaboration. Lacey et al. (2015) make similar observations about the broader field of climate change adaptation research, of which CS is arguably one component. They assert that it is critical for researchers to examine their role and responsibilities in adaptation research, echoing the GFCS framing of climate adaptation as a response to real risks to individual and community health and well-being.

NOAA WESTERN REGION CLIMATE SERVICES DATABASE

While simply providing a catalog of CS providers will not address the many challenges of providing and supporting those services as outlined above, we see this project as a first step in a long-term process that will, among other things:

- help close the gap between climate information users and providers by easing the process by which users can identify and locate potential climate information providers;

- help funders and providers prioritize future work by identifying current gaps in service provision, particularly in terms of underserved areas, sectors, and specific services;

- begin the process of regional coordination to close gaps and eliminate unnecessary overlap in services (although some overlap is important as we continue to explore new ways to best meet users' needs); and

- form the basis of a system of evaluation and feedback about providers by allowing users to reflect on which providers are particularly strong in certain aspects of CS provision.

OVERVIEW OF CLIMATE SERVICE PROVIDERS

The focus of this project was on cataloging and describing CS providers either based in the eleven states comprising the NOAA West region or providing services to that region. The database largely consists of providers within the region (116 of 136 providers), but also includes providers from outside the region who either specifically serve regional information users or are national programs that provide services to all regions (20 of 136 providers).

We limited this database to public-sector programs or non-governmental organizations (NGOs). This decision was partly logistical; we found that identifying and describing public-sector and NGO programs was a large enough task to use our full capacity on this project. Additionally, over the course of this project we became aware of an effort by AMS to undertake a similar effort that is focused on private-sector CS providers. Rather than duplicate efforts, we decided to wait until the AMS database is operational to see both how the efforts could be linked and whether key providers are still missing. The main contact for the AMS effort is Stephanie Herring from NOAA's National Centers for Environmental Information (NCEI) (stephanie.herring@noaa.gov).

METHODS

This effort to catalog CS providers in the NOAA West region should be considered a first step in what could be a long-term process of identifying, networking, and assessing the entire range of CS activities in the region. To begin this process, we chose to limit our initial inquiries to CS providers we could identify through our professional networks, through detailed Internet searches, and through the NOAA West team's professional networks. We started by listing the CS providers we work with (or for), then expanded the list to include other known providers in the region. Once we had exhausted our network, we began an Internet search starting with links or other connections from our "known" list and then expanding using search terms such as *climate service*, *climate adaptation*, *climate assessment*, *climate*

Las Cruces and the Organ Mountains. Photo: Wikimedia Commons, Abraham Sanogo.

data, and then *climate [by sector]* and *[by state]*. Searches yielded hundreds of organizations but most were rejected because they only provided information in a static format and did not demonstrate any interactive dimensions that define CS as identified above. Once we compiled a list of providers in the region, we asked for input from the NOAA West team, who reviewed our list and suggested additional providers or recommended removing a provider whose mandate did not adequately meet the standards of CS provision. At one point, the database contained 189 providers; after review by the NOAA West team and re-review by project team members, the database has been narrowed to 136.

TYPES OF PROVIDERS

By "Climate Service Provider" we mean the organization responsible for serving climate information or other services to stakeholders. We narrowed our definition to include only those organizations that provide services on a consistent basis. We did not include organizations who have only produced one or two products, for example, but looked for evidence of on-going service.

We found that most public sector CS providers fall into one or more of four categories: those primarily funded and/or managed by federal programs (Federal), those primarily funded and/or managed by universities (University), those primarily funded and/or managed by state programs (State), or non-governmental (Non-profit) programs, findings which are consistent with the fact that we intentionally did not search for private sector CS providers. These categories are indicated as "Provider Type" in the database. There are many instances of collaborations or shared funding and management among these categories. For example, the Landscape Conservation Cooperatives (LCCs) and the National Climate Assessment (NCA) are both federal-only providers because they are both funded and managed by federal entities. Regional Integrated Sciences and Assessments (RISAs) and Climate Science Centers (CSCs) are cataloged as both Federal and University because both types of entities share in the funding and management of the programs.

State-funded programs tend to be state climatologist offices and state departments of natural resources or water resources that devote significant resources to climate information. Some of these, like the state climate offices in Arizona and Nevada, are located in universities and are therefore counted as State and University. In some cases, such as the state water institutes, the programs are shared between states and a federal agency (the Department of the Interior via US Geological Survey). One program, the Climate Impacts Group, is funded by a municipality (King County, WA).

Provider Type	Count
Federal	66
University	66
State	25
NGO	16
Municipal	1
Federal and University	29
State and University	10

Table 1. CS Provider Type

We also looked at which agencies or departments are funding or providing climate services. These are listed as "Funding-Agencies" and "Funding-Programs" in the database. It is not surprising to see Department of the Interior (DOI) and the National Oceanic and Atmospheric Administration (NOAA) at the top of the list of funding agencies. DOI has made a significant investment in climate services in recent years, for example through the CSCs (DOI 2010) and LCCs. NOAA has been pioneering the work of climate service provision through its extensive regionally based network of program partners (e.g., the RISA program, U.S. Integrated Ocean Observing System [IOOS] Regional Associations, Sea Grant) as well as, for example, through the reorganization of the National Weather Service (NWS) to focus on providing end-users more usable information (NOAA - NWS 2011).

The State of California is the next most common funder, reflecting that state's investment in climate change adaptation planning efforts. Other states and federal agencies have one or two programs in the region. And in some cases, we were not able to determine the main funding source of a particular program (36 out of 136 funders remain unknown at this time).[1]

Funding Agency	Count
DOI	27
NOAA	22
NSF	14
State of California	13
USDA	6
State of Oregon	4
EPA	2
NASA	2
State of Idaho	2
State of Washington	2

Table 2. Funding Agency

---

1 NOAA's National Integrated Drought Information System (NIDIS), IOOS, and the National Ocean Service (NOS) were not identified as funding agencies or providers in our original data collection process. This may be because of how their funded programs highlight such information on their websites or because of the nature of the programs that were identified in the original database. Their omission from the database should not be taken to mean they do not provide climate services, but speaks more to the type of climate service activities in which they are involved. In future revisions we will attempt to clarify their activities in climate services and include them in the database.

Fish and Wildlife Service worker on boat checking gillnet full of fish. Photo: U.S. Fish and Wildlife Service, Pedro Ramirez Jr.

LOCATIONS OF PROVIDERS

We looked at where the CS providers in the region are located ("State-Based" in the database). We used their physical address to determine the state. We found that most are in California, Colorado, Arizona, and Oregon (Figure 1). Given California's fairly progressive stance on climate adaptation and its large population, it is not surprising to see such a high concentration of CS providers in that state. Colorado is the home to a number of federal facilities focused on climate-related research. All three of Arizona's universities have made major investments in climate-related research; University of Arizona alone is home to five CS providers and Arizona State University hosts three programs.
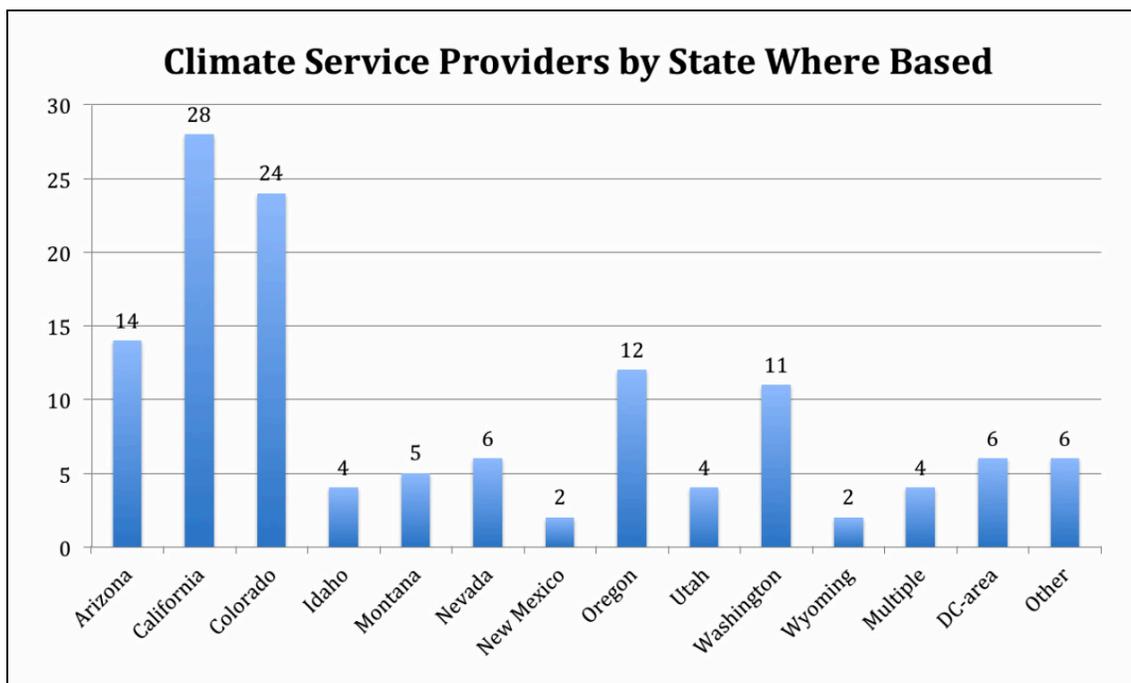

Figure 1. CS Providers by State Where Based

STATES SERVED

Figure 2 describes the number of providers serving each state. While some of the service providers in the database serve all states (and international users in some cases), we focused on states within the NOAA West region. Again, California is served by the most providers (36); all other states are covered by 13 to 22 CS providers.

By comparing the number of providers in a state with the number of providers who cover a particular state (Figure 3), we can see some potential areas for future growth in CS provision. For example, there are only two CS providers in New Mexico, but 13 providers cover the state, indicating that New Mexico's climate service users must be relying on providers from outside the state. There may be demand for additional providers within the state, which could enable more face-to-face interaction between providers and users.
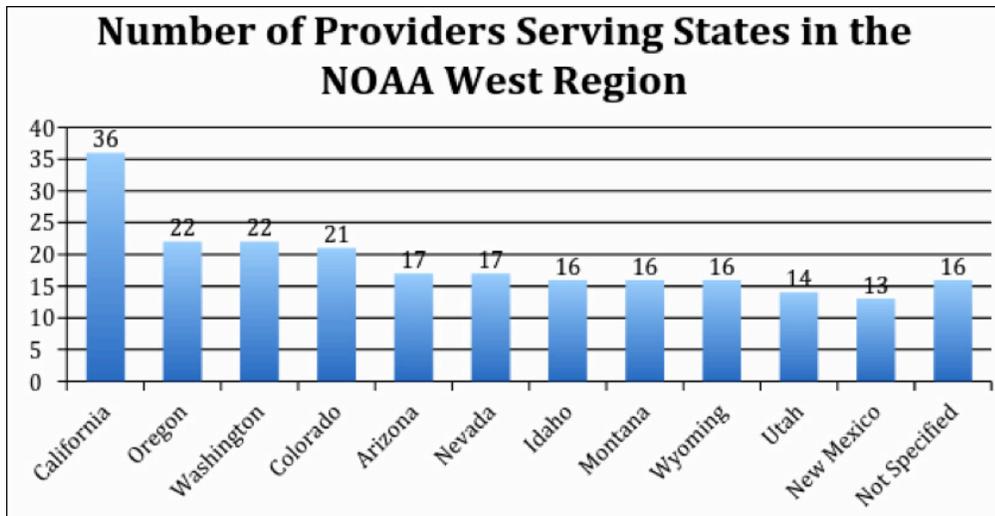

Figure 2. Number of Providers Serving States in NOAA West Region
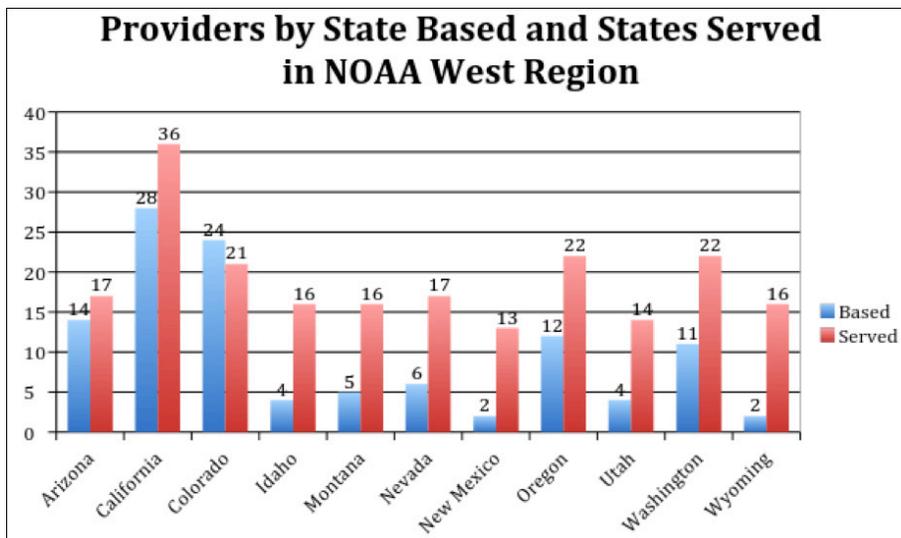

Figure 3. Providers by State Based and States Served in NOAA West Region

SECTORS SERVED

When determining which sectors to track (Table 3), we relied primarily on those identified in previous climate assessments such as the U.S. National Climate Assessment (NCA3) and the Intergovernmental Panel on Climate Change (IPCC) AR5 Working Group II report, but also added others that were commonly listed or implied on providers' websites or other outreach materials. Below is an example of other assessments we consulted when selecting sectors to catalogue.

Sector	National Climate Assessment	US Climate Resilience Toolkit	California Climate Assessment	IPCC AR5 WGII (2015)	WRCS Database
Agriculture					*
Biogeochemical Cycles	*		*		*
Climate and Weather					*
Coastal Systems and Low Lying Areas		*		*	
Coasts			*		*
Drought					*
Economics					*
Ecosystems	*	*	*		*
Energy	*	*	*		*
Energy, Water and Land	*				
Extreme Events					*
Food Security and Food Production Systems		*		*	
Forests	*				*
Freshwater Resources				*	
Health		*	*	*	*
Human Security				*	
Indigenous Peoples	*	*			*
Key Economic Sectors and Services				*	
Land use and Land Cover Change	*				*
Livelihoods and Poverty				*	
Ocean Systems				*	*
Rural Communities	*			*	*
Social					*
Terrestrial and Inland Water Resources				*	
Transportation	*	*			*
Urban	*			*	*
Water	*	*	*		*

Table 3. CS Sector Comparison

The definition of activities or information included in each sector is summarized in Table 4. Most definitions were drawn from their uses in the assessments discussed above or were modified slightly to better describe the sectors as used in this region.

Sector	Definition
Agriculture	Pertaining to farming and ranching practices.
Biogeochemical Cycles	Climate impacts on biogeochemical cycles and the resulting impacts on biodiversity, food security, human health, and water.
Climate and Weather	Information about climate and weather including historical records, paleoclimate records, and projections.
Economics	Costs or benefits related to climate change; impacts to economy.
Ecosystems	Changes or impacts to ecosystems or wildlife.
Energy	How various energy portfolios, extraction methods, and uses impact climate and how climate change may impact energy portfolios, extraction methods, and uses.
Extreme Events	Climate and weather events outside the normal or average range, including planning, mitigation, and information about specific events.
Drought	Planning, mitigation, response, and current and historical information about drought conditions and impacts.
Forests	Impacts of climate change on forest productivity and forest health.
Human Health	Impacts to human health, planning, response, and mitigation of climate impacts to human health.
Indigenous Peoples	Information about climate impacts, planning, and mitigation aimed specifically at Indigenous (tribal) peoples and their lands.
Land Use/Land Cover Change	Transition of landscapes, changes in land cover; carbon sequestration.
Wildfire	Impacts of climate change on wildfire regimes; planning, response, and mitigation of wildfires.
Oceans and Coasts	Climate impacts to oceans and/or coasts; planning, response, and mitigation of impacts.
Rural Communities	Climate-change impacts unique to rural communities and residents.
Social	Addresses specific impacts, responses, and mitigation of climate change on vulnerable populations such as the elderly, poor, non-English speakers, etc.
Transportation	Impacts of climate change, planning, response, and mitigation of impacts on the transportation sector and effects that transportation has on the climate system.
Urban	Climate-change impacts unique to large urban areas and residents (such as confluence of higher temperatures and urban heat islands).
Water	Quantity and quality issues related to uses for municipal, industrial, agricultural, ecosystem services, tourism, recreation, energy production, etc.

Table 4. Sectors Served by Providers

SCALES SERVED

Much like "Provider Type", most CS organizations provide information at more than one geographic scale. We identified six general scales served: international, national, regional, tribal, state, and municipal. Ninety-two organizations provide information at a state scale (68% of providers), while only 18 (13%) provide information at tribal scales. There are 231 tribes in the NOAA Western region, all of whom are likely to be experiencing climate impacts (Bennett et al. 2014; Redsteer et al. 2013). We focused most of our searching on organizations that serve stakeholders in the NOAA West region, so the low number of international providers is not surprising – although several providers do work across the borders into Mexico and Canada given the transboundary nature of watersheds and ecosystems.

The Colorado River between Marble Canyon. Photo: Wikimedia Commons, Alex Proimos.
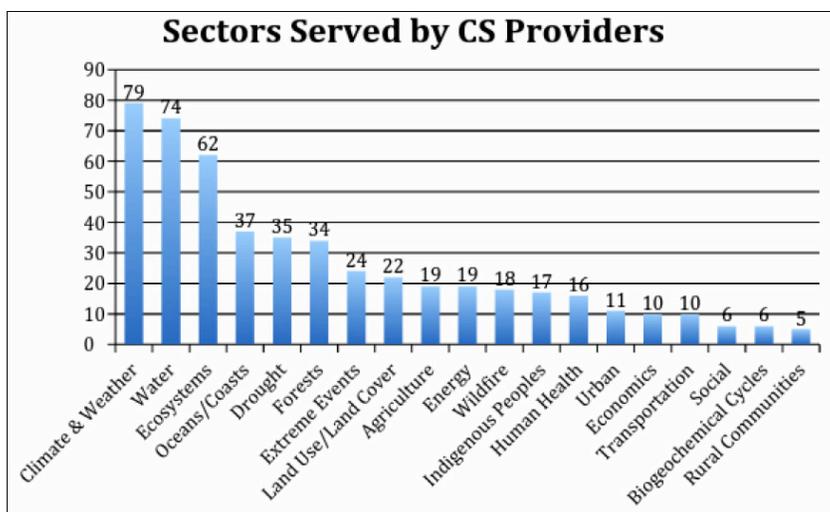

Figure 4. Sectors Served by Providers

Scale Served	Provider Count
International	16
National	29
Regional	77
Tribal	18
State	92
Municipal	45

Table 5. Scales Served

SERVICES PROVIDED

We identified 14 different types of services offered by CS providers in the region. Some of these are straightforward – like the provision of data, reports or white papers, and peer-reviewed articles. Some are less tangible but have been identified as important services provided by boundary organizations, such as convening (i.e., bringing key players together to collaborate on problem-solving) (Cash et al. 2006). Definitions of services are summarized in Table 6. Most CS organizations provide several services.

| Climate Service	Definition
Convening	Bringing people together to collaborate.
Coordination	Connecting different people or organizations into new relationships.
Data	Development, collating, and sharing of data sets.
Decision-Support Tools	Computer-based programs and products develop to aid decision analysis in various climate-related decisions
Monitoring and Evaluation	Ongoing efforts to collect, disseminate, and evaluate various climate-related conditions or impacts.
Newsletters	Bulletins produced periodically for audiences external to the service provider.
Peer Reviewed Publications	Research published in relevant journals and books that have been vetted by other researchers in the relevant fields.
Presentations	Live or archived presentations.
Reports/White Papers	Research shared in publications that have not been peer-reviewed.
Scenarios/Models	Climate information in the form of possible future scenarios or models of future conditions.
Trainings & Education	Materials, activities, and products aimed at increasing one's understanding of a particular subject (includes K-12, higher education, professional development, or trainings for the general public).
Vulnerability Assessments	Identification and evaluation of vulnerabilities to climate variability and change.
Webinars	Online presentations and educational activities.
Workshops	Meetings with intensive discussion or activities related to a particular subject or project.

Table 6. Sectors Served by Providers
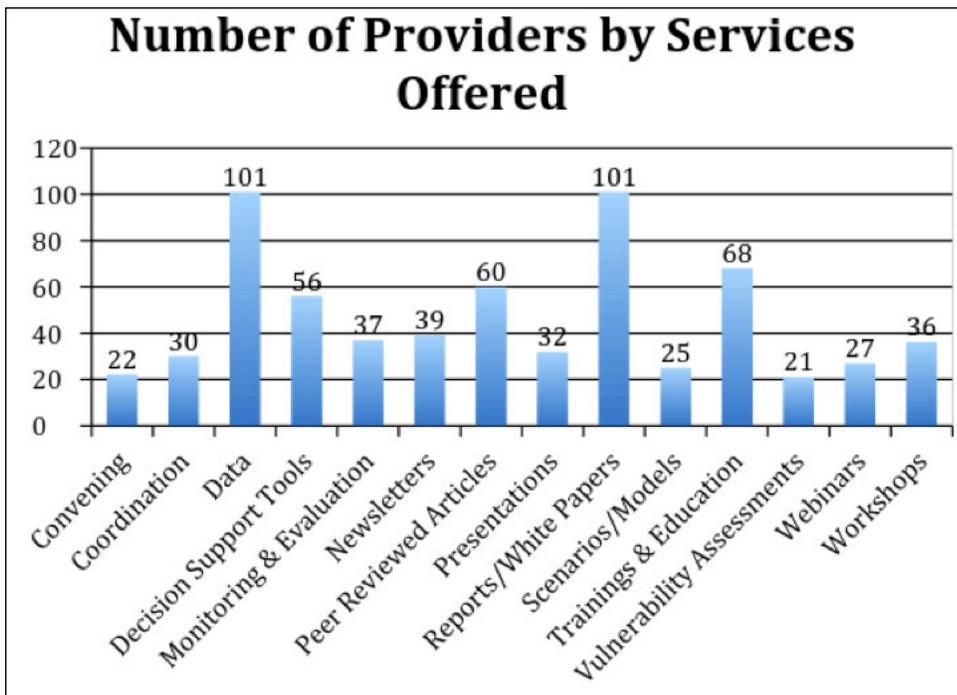
Figure 5. Number of Providers by Services Offered

The Oregon coastline looking south from Ecola State Park. Photo: Wikimedia Commons, Cacophony.

Figure 5 shows that the provision of data is one of the two most common services provided, along with production of reports and white papers (each are representative of 101 out of 136 organizations, or 74%). However, we also know from the literature on climate-service provision cited above that simply providing data is often insufficient to meet the needs of decision makers. We looked at the number of providers who combine the provision of data with an interactive method of delivering that data to a potential user (Table 7). The number of providers who combine these approaches is significantly smaller than those simply providing data alone. This is a very coarse analysis and a much more detailed data collection process, including interviews, document analysis, and even participant observation would be required to comprehensively understand the ways in which regional providers are working with climate information end-users.

Service Provision	Provider Count
Data + Convening	13
Data + Coordination	17
Data + Trainings/Education	48
Data + Workshops	23

Table 7. Service Provision

STAKEHOLDERS SERVED

Many CS providers listed the types of people or organizations they consider to be primary stakeholders or users of their climate information. We identified six general categories of stakeholder (summarized in Table 8 below).

Climate Service	Definition
Government	Representatives of agencies at municipal, state, tribal, or federal levels; includes policy-makers (elected officials).
Public	General public.
Private Sector	Organizations that are privately held.
Researchers	Researchers from within or outside of the academy.
Resource Managers	Decision makers working directly with natural resources (e.g. water, forests, rangelands, fish and wildlife); can include public and private sector.
Tribes	Representatives of tribal nations and communities.

Table 8. Definition of Stakeholders

Governmental users were by far the most commonly identified stakeholders (78% of CS providers serve government decision makers). The next most-common type of stakeholder is resource managers, served by 69% of providers; then the general public, served by 68%. Researchers (49%) are the next most common stakeholder type, trailed considerably by tribes (only 17%). There is undoubtedly some overlap in these categories – for example, many resource managers are government employees and some may be members of the general public (i.e. ranchers or farmers). This is an area that will require further investigation when both CS users and providers are asked in greater detail about their interactions. And without a detailed survey of climate service stakeholders in the region, we have no way to judge whether all needs are being met or whether there is greater demand from certain constituencies.

Service Provision	Provider Count
Government	107 (78%)
Private Sector	72 (53%)
General Public	93 (68%)
Tribes	23 (17%)
Researchers	67 (49%)
Resource Managers	95 (69%)

Table 9. Stakeholder Type

We looked at patterns of stakeholders by program-provider type (federal and state providers only; see Figure 6). We found that both federal and state providers target government information users (80% of federal programs and 88% of state programs). Federal and state providers are also fairly even when it comes to providing services to the private sector (52% and 60% respectively). But there are more substantial differences when it comes to providing services to the general public: state-funded or managed programs are much more prominent (92% versus only 61% of federal programs). No state-funded or managed program lists tribes as primary stakeholders. Historically, there has been no government-to-government relationship between tribes and states and, therefore, no obligation for states to work directly with tribes. While this pattern is changing over time as tribes and state recognize their common interests, the formal connections still lag behind. However, the very low number of federal programs that list tribes as stakeholders (18 programs or 27%) is notable because federal agencies do have a trust responsibility to tribes (Getches et al. 1998). Provision of climate services to tribes seems to be an area in which considerably more resources are required. State programs tend not to focus on providing information to researchers (only 24% do), but given their focus on the general public and state-government decision-makers, this may be a conscious decision. Federal programs tend to list resource managers as primary

Lake Powell, Utah. Photo: Wikimedia Commons, PRA.

stakeholders slightly more often than state programs (76% versus 72%), which may be explained by the high percent of federal lands in the West, making federal resource managers a major user of climate services.
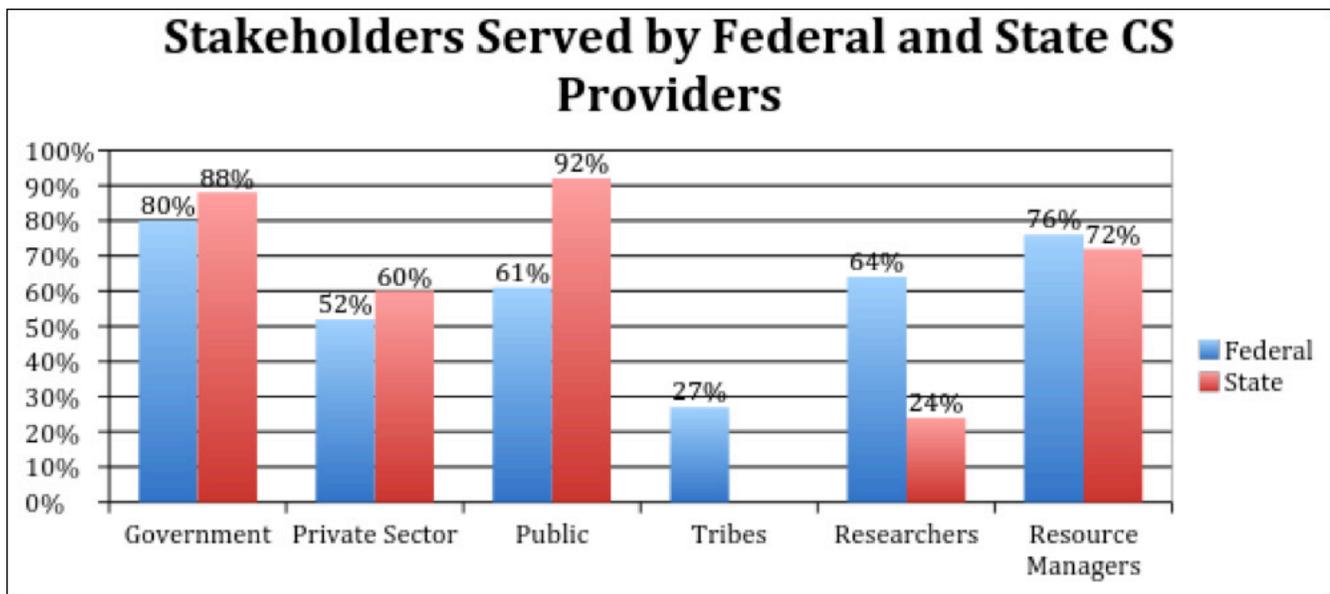

Figure 6. Stakeholders Served by Federal and State CS Providers

SUMMARY OF FINDINGS AND GAPS

Until a survey of CS stakeholders in the region is conducted, we cannot say with certainty whether existing CS providers are or are not meeting demand for climate services; however, we highlight the following potential service gaps in the region. These are areas that NOAA West may wish to investigate further to determine what information and services stakeholders most need but currently cannot access; this approach could be an effective way to focus resources on filling gaps in CS provision.

- New Mexico and Utah have the least coverage by existing CS providers (13 and 14, respectively).

- New Mexico and Wyoming have the largest gaps between number of providers in the state and the number of providers serving the state; there may be an opportunity to invest in local CS providers who can develop long-term relationships with stakeholders.

- Relatively few CS providers are focused on Human Health (16 of 136), Transportation (10 of 136), or Economics (10 of 136).

- Tribes are an underserved stakeholder group; only 18 providers (27%) in the West list tribes as primary stakeholders. Yet there are 231 tribes in the region – all of whom are likely to be experiencing climate impacts of some kind (Bennett et al. 2014; Redsteer et al. 2013). All other stakeholder groups are served by at least 50% of the CS providers.

NEXT STEPS

Our independent data collection phase is now complete and all 136 CS providers have been entered into a searchable database. Currently, the database exists in FileMaker Pro, which requires a license to use. An online, publicly accessible version of the database is currently under development by the WRCC. We are currently in the process of verifying the information in the database with the CS providers but this is a slow process because of delays in developing the database. We are asking providers in the database to verify their basic profiles (names, contact information, mission statements), and to select three to five key sectors, services, and stakeholders they work with. By limiting each provider to no more than five choices we hope to limit the chances that providers will select all options, which would limit the utility of the database (e.g., it would not be possible to use a keyword search to narrow a selection of providers). All current categories will remain in the database, but CS providers will be cataloged only by the services, sectors, and stakeholders they identify as the most prominent foci for their organizations.

Two other key caveats are necessary regarding the database: the effort of cataloging providers can tell us nothing about the quality of the services they provide nor their credibility/value to CS users in the region. We would like to propose to begin that assessment of various providers through a modified social network analysis approach. We could contact known CS users in the region (again beginning with our professional networks and expanding from there) and ask them to select from the list of providers those they most often work with, on what kind of issues, and what kind of services they receive. We may then begin to see patterns regarding which CS providers are most often consulted, which services are most in demand, and what kind of stakeholder asks for what kind of service. This analysis is not possible with the current resources, but could be a follow-on project if more resources are allocated.

An important next step is for the NOAA West team to work with the WRCC database developers to establish a plan to update and maintain the database. As the primary users, it is important that the NOAA West team set the parameters for how often, when, and why the database is updated.

REFERENCES

Adams, P., E. Eitland, B. Hewitson, C. Vaughan, R. Wilby, and S. Zebiak, 2015: Toward an ethical framework for climate services: A White Paper of the Climate Services Partnership Working Group on Climate Services Ethics. Available at: http://www.climate-services.org/wp-content/uploads/2015/09/CS-Ethics-White-Paper-Oct-2015.pdf

Bennett, T. M. B., N. G. Maynard, P. Cochran, R. Gough, K. Lynn, J. Maldonado, G. Voggesser, S. Wotkyns, and K. Cozzetto, 2014: Ch. 12: Indigenous Peoples, Lands, and Resources. Climate Change Impacts in the United States: The Third National Climate Assessment, J. Melillo, T. Richmond, and G. W. Yohe, Eds., 297-317. doi:10/7930/J09G5JR1

Brasseur, G.P. and L. Gallardo, 2016. Climate services: Lessons learned and future prospects. Earth's Future, 4, doi:10.1002/2015EF000338

Cash, D. W., J. C. Borck, and A. G. Patt, 2006: Countering the loading-dock approach to linking science and decision making: comparative analysis of El Niño/Southern Oscillation (ENSO) forecasting systems. Sci. Technol. Hum. Val., 31, 465-494. doi: 10.1177/0162243906287547

Coughlan de Perez, E., and S. J. Mason, 2014: Climate information for humanitarian agencies: some basic principles. Earth Perspectives, 1. doi:10.1186/2194-6434-1-11

Dilling, L., and M. C. Lemos, 2011: Creating usable science: opportunities and constraints for climate knowledge use and their implications for science policy. Glob. Environ. Change, 21, 680-689. doi:10.1016/j.gloenvcha.2010.11.006

Getches, D. H. W., F. Charles, and R. A. Williams, Jr., 1998: Cases and Materials on Federal Indian Law, fourth edition. West Group.

GFCS 2012: http://www.gfcs-climate.org

Guido, Z., D. Hill, M. Crimmins, and D. B. Ferguson, 2013: Informing decisions with a climate synthesis product: implications for regional climate services. Wea. Climate Soc., 5, 83-92. doi:10.1175/WCAS-D-12-00012.1

Lacey, J., S. M. Howden, C. Cvitanovic, and A.-M. Dowd, 2015: Informed adaptation: Ethical considerations for adaptation researchers and decision-makers. Glob. Environ. Change, 32, 200-210. doi:10.1016/j.gloenvcha.2015.03.011

Máñez, M., T. Zölch, and J. Cortekar, 2013: Mapping of Climate Service Providers –Theoretical Foundation and Empirical Results: A German Case Study. CSC Report 15, Climate Service Center, Germany.

McNie, E. C., 2013: Delivering Climate Services: organizational strategies and approaches for producing useful climate-science information. Wea. Climate Soc., 5, 14-26. doi:10.1175/WCAS-D-11-00034.1

McNie, E. C., 2007: Reconciling the Supply of Scientific Information with User Demands: An Analysis of the Problem and Review of the Literature. Env. Sci. & Policy, Vol. 10, 17-38.

Melillo, J. M., T. C. Richmond, and G. W. Yohe, Eds., 2014: Climate Change Impacts in the United States: the Third National Climate Assessment. U.S. Global Change Research Program, Washington, D.C.

Miles, E. L., A. K. Snover, L. C. Whitely Binder, E. S. Sarachik, P. W. Mote, and N. Mantua, 2006: An approach to designing a national climate service. Proc. Natl. Acad. Sci., 103, 19616-19623.

National Weather Service, 2011: Weather-Ready Nation: NOAA's National Weather Service Strategic Plan 2011. National Oceanic and Atmospheric Administration.

Redsteer, M. H., K. Bemis, K. Chief, M. R. Gautam, B. R. Middleton, and R. Tsosie, 2013: Unique Challenges Facing Southwestern Tribes. Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment, G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, Eds., Island Press, 385-404.

Srinivasan, G., K. M. Rafisura, and A. R. Subbiah, 2011: Climate information requirements for community-level risk management and adaptation. Climate Res., 47, 5-12. doi:10.3354/cr00962

U.S. Dept. of the Interior. Secretary of the Interior, 2009: Order no. 3289: Addressing the Impacts of Climate Change on America's Water, Land, and Other Natural and Cultural Resources.

U.S. Government Accountability Office, 2015: Climate Information: A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information. GAO-16-37, November 2015. Available at http://www.gao.gov/assets/680/673823.pdf

Vaughan, C., and S. Dessai, 2014: Climate services for society: origins, institutional arrangements, and design elements for and evaluation framework. Wiley Interdiscip. Rev.-Clim. Chang., 5, 587-603. doi:10.1002/wcc.290