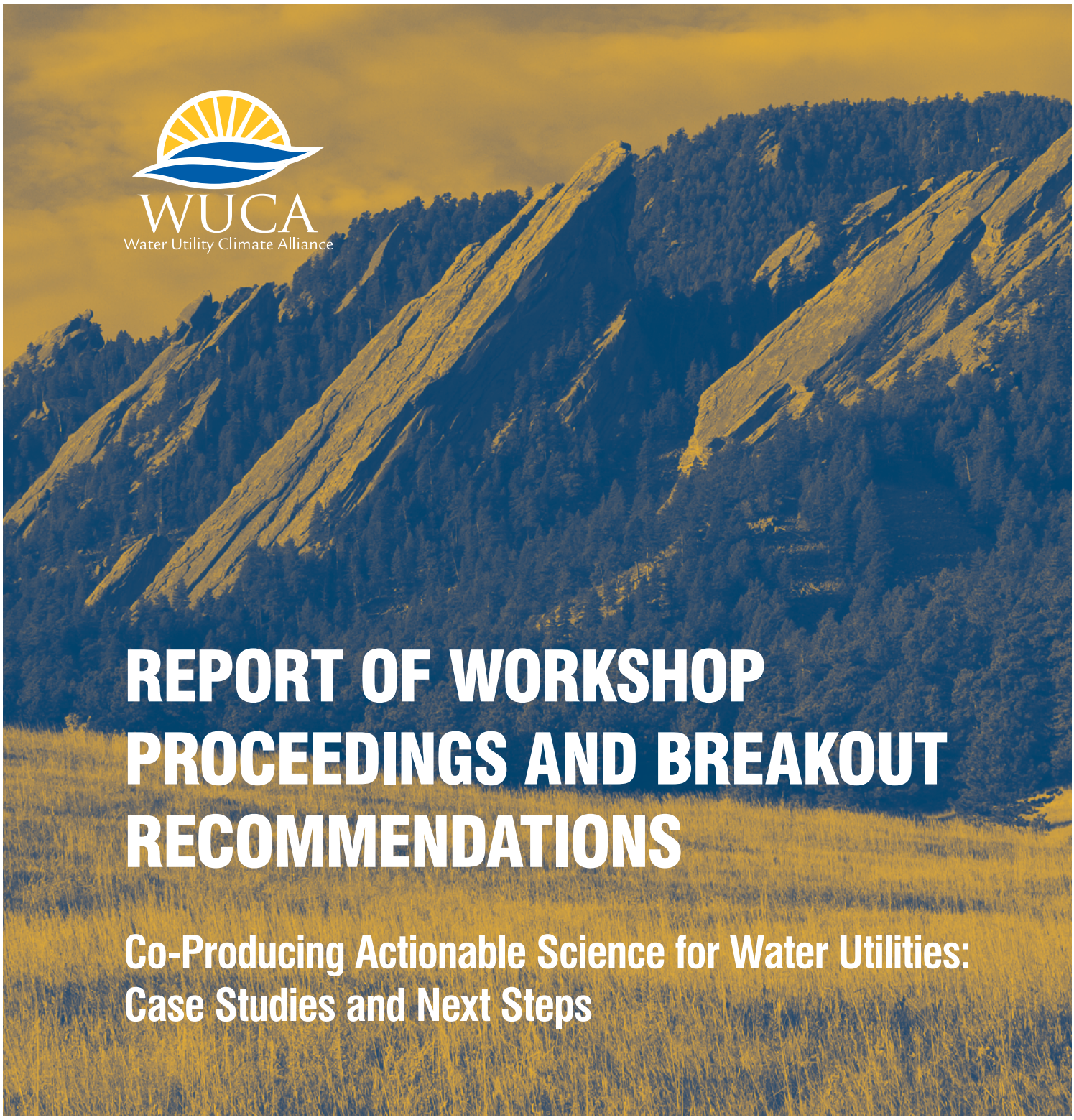

WUCA
Water Utility Climate Alliance

REPORT OF WORKSHOP PROCEEDINGS AND BREAKOUT RECOMMENDATIONS

Co-Producing Actionable Science for Water Utilities: Case Studies and Next Steps

May 2-3, 2016
National Center for Atmospheric Research
Boulder, Colorado

Sponsored by the Water Utility Climate Alliance

I. Overview and Leadership

In May of 2016, over 50 experts from the drinking water, boundary organization, academic, federal agency, and NGO communities came together in Boulder at the invitation of the Water Utility Climate Alliance (WUCA). The goal: to hear reports from WUCA's Piloting Utility Modeling Applications (PUMA) Project and to brainstorm how to build on that experience and on decades of evolving practice in the climate services arena by envisioning what a "water climate service pilot project" might look like.

Workshop Steering Committee:

David Behar, San Francisco Public Utilities Commission (Chair)
Tirusew Asefa, Tampa Bay Water
Dan Ferguson, Climate Assessment for the Southwest (CLIMAS)
Paul Fleming, Seattle Public Utillities
Gregg Garfin, University of Arizona
Adam Parris, Science and Resilience Institute at Jamaica Bay
Chris Weaver, Environmental Protection Agency and the USGCRP

Workshop Manager: Darrin Sharp, Oregon Climate Change Research Institute
Workshop Report Manager: Rebecca Smith, University of Colorado
Workshop Report Associate: Angeline Pendergrass, University of Colorado

Report produced August 2016

II. Workshop Panels and Discussion

Workshop introduction, background and goals (adapted from keynote presentation by David Behar)

The Water Utility Climate Alliance (WUCA) envisioned and sponsored this workshop. The mission of WUCA is to provide leadership in assessing and adapting to the potential effects of climate change through collaborative action. WUCA seeks to enhance the usefulness of climate science for the adaptation community and improve water management decision-making in the face of climate uncertainty. The jumping off point for the workshop was WUCA's Piloting Utility Modeling Applications (PUMA) project: vulnerability assessments at four utilities– Portland Water Bureau, Seattle Public Utilities, New York City Department of Environmental Protection, and Tampa Bay Water – that wrapped up their most recent phase of work last year (see the white paper at www.wucaonline.org). WUCA intends to build on this work, and believes the PUMA case studies, and others presented on Day 1, offer lessons for future work seeking to bring science and decision making together. The workshop concluded with breakout groups asked to build on collective knowledge and the workshop content to envision what a "water climate service pilot project" might look like and to determine some of the basic needs for such an entity to succeed.

Three important concepts animated this workshop: climate services; actionable science; and co-production.

Climate Services: there are many definitions, most imperfect. One, from the Global Framework for Climate Services, says climate services are:

> Climate information provided in a way that assists decision-making by individuals and organizations. (It) requires appropriate engagement along with an effective access mechanism and must respond to user needs. [1]

Co-production recognizes the essential value provided by both decision maker and scientist in identifying vulnerabilities to climate change. According to "Guiding Principles and Recommended Practices for Co-producing Actionable Science" produced by the federal Advisory Committee on Climate Change and Natural Resource Science (ACCCNRS), in a co-production environment:

> The manager provides insights into the planning issues in play, the downstream analytic tools used to evaluate system operations, and their plan on how to use scientific information in their assessment, and
>
> The scientist brings insights into the nature of the science that might be used in assessment, the most appropriate use of the science, clear characterization of uncertainties, and potential avenues for research that might create value for the decision maker. [2]

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[1] Brasseur, G. and L. Gallardo. Climate Services: *Lessons Learned and Future Prospects.* Accepted article doi:eft2.2015EF000338. Undated.

[2] Beier P, D. Behar, L. Hansen, L. Helbrecht, J. Arnold, C. Duke, M. Farooque, P. Frumhoff, L. Irwin, J. Sullivan, J. Williams (Actionable Science Workgroup of the Advisory Committee on Climate Change and Natural Resource Science). 2015. *Guiding principles and recommended practices for co-producing actionable science: a How-To Guide for DOI Climate Science Centers and the National Climate Change and Wildlife Science Center.* Report to the Secretary of the Interior: Advisory Committee on Climate Change and Natural Resource Science. Washington, DC. Accessed at https://nccwsc.usgs.gov/sites/default/files/files/How-to-Guide_Formatted_Aug%2013%202015.pdf.

Actionable science is a term that was first defined by WUCA in 2009 which has become ubiquitous since then. It appears in one form or another in such places as the President's 2013 Climate Action Plan; Executive Orders 13653 and 13690; the USGRP's 10 year strategic plan; and the Global Framework for Climate Services. An updated definition was crafted by ACCCNRS in 2015:

> Actionable science provides data, analyses, projections, or tools that can support decisions regarding management of the risks and impacts of climate change. It is ideally co-produced by scientists and decision-makers and creates rigorous and accessible products to meet the needs of stakeholders. [3]

Discussion of some fundamental concepts during the workshop

Throughout the workshop there was discussion of what constitutes co-production and how its success or failure should be evaluated. While workshop goals did not include deep dives into precisely answering these questions, the discussions on these topics were lively and are worthy of follow up.

Some participants maintained that unless scientists receive a clear benefit, they are in more of a consulting role than equal partners. While decision makers and scientists may have different motivations for engaging in co-production, the positive impact of any project is increased if scientists' findings can influence future research efforts – even those not undertaken as part of a co-production process – for improved data or tools.

Another point of contention was the appropriate applications of loading dock vs. co-production models of scientific development and transmission. Workshop participants generally felt that both have their place, but that decision makers are highlighting a need to generate practical research applications through engagement in co-production with scientists. Furthermore, some felt the division between loading dock and co-production is a false dichotomy since research – and even co-production – occurs on a continuum and can take many forms.

DAY 1 – THE PUMA PROJECT

The first morning session consisted of presentations from three co-production assessment projects at Portland Water Bureau, Seattle Public Utilities (both PUMA projects) and Denver Water. This was followed by Synthesis Panel #1, reported immediately below. The second morning session included presentations from NYC Department of Environmental Protection, Tampa Bay Water (both PUMA projects), and the Colorado River Basin Study, and was followed by Synthesis Panel #2, detailed next. Synthesis panels were broadly asked to respond to the three presentations immediately preceding their panel.

Note: All power point presentations for the workshop are referenced in this report and have been saved to http://blogs.oregonstate.edu/puma2016/workshop-presentations/. A white paper detailing processes and findings in the PUMA project, entitled Actionable Science in Practice: Co-Producing

[3] Report to the Secretary of the Interior, Advisory Committee on Climate Change and Natural Resource Science. March 30, 2015. Accessed at https://nccwsc.usgs.gov/sites/default/files/files/ACCCNRS_Report_2015.pdf.

Climate Change Information for Water Utility Vulnerability Assessments, Final Report of the Piloting Utility Modeling Applications (PUMA) Project, *is available at* www.wucaonline.org.

Synthesis panel and plenary discussion #1

Following presentations from PUMA projects at Portland Water Bureau and Seattle Public Utilities and from the experiences of Denver Water

Panel: Martyn Clark, Bets McNie, James Arnott
Moderator: Mohammed Mahmoud

Several of the PUMA utilities were motivated to "build capacity" so they could "take control of the narrative" (rather than remain unable to respond to customer/board questions fueled by increasing exposure to climate change information). This generated a number of participant responses: first, how can these capacity-building lessons be used to benefit utilities with fewer resources who may not be focused on in-house capacity? Second, what role should boundary organizations play as climate education and capacity become more widespread? Third, what is the best way for utilities to interface with science as they gain ability and take more responsibility?

Some researchers expressed that they did not consider the co-production work they had done publishable (but also that publishability was not a requirement for them to engage). Others said they had published much of the work from their co-production efforts. The differences in the projects that may have led to one outcome or another were not explored in detail. Several participants echoed the sentiment that the perceived/real lack of publishing potential could/does inhibit enthusiasm from researchers who are strongly incentivized to publish. One suggestion to address this was for federal program managers to make room for researchers to publish while they also reach out to agencies to conduct this kind of assessment work; another was to "fix" the journals that didn't want to publish work from the science-practitioner interface. On a more meta level, a participant pointed out that it would be ideal to actually elevate the area of scientific inquiry that engages in practitioner outreach.

As intentional projects like PUMA become more common, they need to be supported by strong networks and have people dedicated to documenting: a) what leads to successful bi-directional engagement; b) any unintended consequences of pursuing/incorporating new scientific information (e.g. in press, within utilities); c) laborious processes vs. important outputs used in decisions; d) repurposing of previously-developed products/resources; and e) future research agendas to facilitate meeting practitioner needs.

Synthesis panel and plenary discussion #2

Following presentations of PUMA projects at New York City Department of Environmental Protection and Tampa Bay Water, and from the Colorado River Basin Study

Panel: Lisa Dilling, Casey Brown, Joe Barsugli
Moderator: Brandon Goshi

Toward the end of Day 1, panelists and participants were less inclined to reflect on the completed projects and more interested in what questions should be answered next. There was strong emphasis on how educating technical staff did not itself translate to influencing utility decisions. What role does technical information play in the decision making process? How does uncertainty impact decisions? What if boards still just want a number (rather than a range)? If these things are unclear, how should researchers seeking to produce actionable science proceed?

Regardless of whether climate-informed decisions are imminent, the efforts of the pilot utilities and their academic and boundary organization collaborators have created capacity for evaluating vulnerability and the space for conversations with boards and other regional entities to begin. This workshop showed two examples of regionalization of climate science-integration efforts: the Florida Water and Climate Alliance (see Graham presentation) and the ongoing quarterly meetings resulting from the Join Front Range Climate Change Vulnerability Study in Colorado (see Kaatz presentation). Both began with strong support from a WUCA utility and benefitted from having a large number of engaged research institutions in the area. They can serve as prototypes for how to parlay the efforts of larger utilities into benefits for smaller utilities – a process that needs to be investigated and possibly replicated as a way for utilities with fewer resources to have access to, and input on, efforts to study and implement climate change adaptation. These gains have been crucial, since in many places the states are not providing incentives or guidance.

One panelist suggested that preparedness doesn't need to start with GCMs. What is learned by looking at the means and extremes of GCM output when those are almost certainly not the real means and extremes? Probability has a place in this conversation, but a more formal approach is warranted. Also, it takes a lot of time and effort to translate GCM output into downscaled inputs for use in a custom-built hydrologic model. Many different participants mentioned that either their utilities did or utilities in general should learn about their systems' specific vulnerabilities because knowledge about these can help to guide planning in more of a bottom-up approach; if utilities do this first, it could also hone the pursuit of incorporating GCM data.

It's also important to think about shorter term uncertainty (the next 5-20 years) and how building in adaptation capacity now improves your longer term outlook. The researchers who think about decision making in a structured way (e.g. engineering researchers) need to be brought into the conversation to make this work "essential" and to address the operationalization question. Some participants advocated for more focus on putting imperfect science into action and getting onto the decision-making agenda rather than spending the majority of future effort on getting more/better science. Co-production with decision support scientists would be valuable for the field since currently there is not enough real-world decision context informing research, but it's important to articulate what the goals of such efforts would be and how they would be measured before advocating for additional funding.

Communication challenges were noted in several contexts – between scientific disciplines, between technical staff and utility boards, and with the public. Language barriers, even between researchers working on the same project but from different fields, are problematic and prevent the flow of useful information among academics and between academics and practitioners. Technical utility staff say that communicating uncertainty to their boards is one of their hardest jobs, especially when trying to translate the risks and rewards of adaptation strategies. The Colorado River Basin Supply and Demand Study was an example of extensive effort made to communicate the implications of climate uncertainty to the public; it was very challenging even to go from the mean to the interquartile range

of scenario projections in a way that citizens at Reclamation's outreach meetings could understand. Would it be better to develop a new way to track vulnerabilities within the partially-characterized cloud of uncertainty than pursue the current way this information is presented?

Puma in the larger context: panel and plenary discussion #3

Question posed: What do today's presentations teach us about principles of climate services, co-production, and boundary spanning – in particular for the water sector?

Panel: Richard Moss, Dan Ferguson, Edward Campbell, Bets McNie, Guy Brasseur
Moderator: Adam Parris

Context and customization of data, methods, and tools are critical; what do these characteristics teach us about the future of climate services? Future PUMA-like efforts need to be planned carefully and be well-documented to capture micro and macro processes. The agendas and proposals should be the result of input from knowledge networks to ensure usability of output/results.

Are utilities really committed to co-production, or just interested in getting information from scientists? What are utilities willing to contribute to science? How closely do they need to guard their information and the nature of their planning processes? Communication culture is very different in utilities vs. scientific community.

Was PUMA successful? What are the metrics? What the pilot utilities are doing now is better than what they were doing before; capacity has been built. However, one participant noted that, in some cases, these PUMA representatives basically represent "boundary organizations" within their respective utilities; the overall culture within the utilities hasn't really changed, and adaptation projects have not yet been implemented. Since these PUMA pilot projects never intended to address decision support, that isn't a failure – and future work should definitely explore the "softer" work related to decision support. On top of increased capacity within utilities, scientists will have better context when working with other utilities going forward, and that should be a relevant metric.

Understanding decision support tools has not been taken seriously enough as a research problem, though the National Climate Assessment has documented some positive experiences. If a climate service aims to offer broadly useful tools that can be tailored, it needs to identify important problems and information that can be used frequently. For this, understanding decision support is essential, as is addressing the entire spectrum of players that exist between "producers" and "users." Future projects need to be integrated across all (or at least a greater number of) relevant sciences that influence outcomes, not just physical science.

It's very important to figure out how scientists can get more funding for this type of work. How should funding agencies phrase what they're looking for to get different results than are typically produced when these kinds of questions are researched without co-production? Currently they just require letters of support, but that doesn't necessarily translate into true co-production or advancement of actionable science since there are different incentives in play for researchers (funding grad students, getting tenure, etc.) than for utilities. One suggestion is to get creative with framing research questions, another is to clearly articulate the value of what is being studied and how it will be evaluated. Maybe presenting a cost benefit analysis in proposals would be helpful?

DAY 2 – CLIMATE SERVICES LANDSCAPE

Panelists in the Day 2 plenary sessions were asked to speak on specific topics (rather than synthesize others' presentations as in Day 1).

Where have we been? The climate services institutional landscape. Missions and approaches, distinguishing features, supply and demand, success stories and challenges.

Panel: Gregg Garfin, Phil Mote, Roger Pulwarty, Guy Brasseur
Moderator: Christine Kirchhoff

The momentum for climate services grew out of the increased demand for seasonal forecasts after the '97-'98 ENSO event and recognition that large scale climate data generated through existing efforts was not useful at the decision making scale. Since the mid-1990s, a variety of entities have been created or evolved to improve the ability of science to inform resource management. In no particular order (and with no claim of completeness), there exist (1) DOI's Climate Science Centers (CSCs): autonomous regional hubs of the National Climate Change and Wildlife Science Center that focus on fish and wildlife and their habitats; (2) NOAA's Regional Integrated Sciences and Assessments (RISAs): a network of independent regional entities focused on integrating science-producing agencies across scales and building networks of stakeholders for improved local and regional climate preparedness; (3) USDA's regional Climate Hubs: tailoring data and technology to land management applications relevant to farmers, ranchers, etc.; (4) NGOs, e.g. EcoAdapt, the Nature Conservancy: publish guides or databases of adaptation products or case studies for wide use; (5) Landscape Conservation Cooperatives (LCCs): facilitate delivery of regionally-relevant applied science for ecosystem resilience and staffed and supported by a variety of federal, state, tribal, and private agencies; (6) university-affiliated entities, e.g. University Center for Atmospheric Research (UCAR/NCAR), Scripps, Nat'l Drought Mitigation Center; (7) National Labs; (8) DoD's environmental research programs SERDP (jointly affiliated with EPA and DOE) and ESTCP, which are project-oriented, not service-oriented; (9) NOAA's Regional Climate Centers; (10) state-level assessments in partnership with universities and agencies; and (11) National Climate Assessment Network (NCANet): facilitates communication across public, private, and NCA affiliates.

Historically, the plethora of climate services entities within and outside the federal governments don't coordinate and may duplicate efforts or compete for resources. Efforts to address this are underway to some degree. Each excels at different activities, perhaps best illustrated through a scorecard (see Garfin slides).

Two brief funding and structure overviews: RISAs and Landscape Conservation Cooperatives

Like most of the federal climate services (CSCs, USDA Hubs, etc.), RISAs have some central accountability in Washington D.C. They receive base funding from NOAA's Climate Program Office and must re-compete for it at regular intervals. The base funding supports a staff at each regional location which is expected to be appropriate for the range of priorities in that region (a range that should evolve through feedback from a network of stakeholders and, potentially, review boards). The RISA staff is expected to have qualifications and capacity that they can leverage to compete for additional funding. The RISAs do a small amount of coordination to avoid reinventing the wheel where expertise already exists in another region.

Landscape Conservation Cooperatives (LCCs) have a national council with ~25 members that reports to and interfaces with governments and other organizations on the activities of the 22 regional LCCs and identifies high priority issues. Each of the LCCs has a coordinator and a science coordinator. Each LCC is staffed by professionals from other agencies, e.g. BOR, FWS, etc., and the funding for specific projects/efforts is sought from the national LCC coffers as well as from CSCs, NASA, etc.

European climate services perspective

In 2001 the US Academy of Sciences' definition of a climate service focused on delivery of data; in 2015, the EU definition of a climate service included customized products and solutions that make data useful for society at large. In Europe there are both top-down services (e.g. Copernicus Climate Change Service) and bottom-up services (e.g. European Environmental Agency and European Climate Adaptation Platform). Because Europe has made a concerted effort to emphasize the development of usable climate change products, PUMA can learn lessons from their pioneering experience. First, there isn't a clear market for adaptation products because users don't know what they want, they don't yet feel threatened, and it's not yet compulsory to take action; mitigation products are more popular because of legal requirements, and private companies are able to support these. Second, the business model of climate services has been more like those of research institutes where one project can take a year or more; users want answers and products much more quickly. Third, the timescales relevant to climate data are not on the radar for 5-10 year strategic planning.

Where are we now? Information for building climate resilience: opportunities for public/private collaboration

Panel: Joe Thompson, John Nordgren

Now seems to be a transitional time where navigating the labyrinth of climate data can give way to informed planning activities. There is growing recognition that actionable science requires sustained collaboration, alignment, and co-ownership of the knowledge-generation process; when adaptation needs are really considered, co-production is by far the most desirable activity for boundary organizations to engage in, with comparable attainability to "Big Science". If co-production efforts can be focused and harnessed to produce and document examples of building adaptation capacity, they could help the Government Accountability Office make the case to Congress that managing climate change risks to federal assets is important for limiting fiscal exposure. Once things become more operational and the appropriate role for the federal government is defined, increased funding could follow. It was noted that there may be regulatory snags lurking in the future, and the more that federal agencies and local utilities can work together to characterize climate readiness, the easier it will be for utilities to achieve compliance. Private funding, in turn, has focused on place-based initiatives by finding existing capacity and facilitating collaboration between grantees that respects their jurisdictions. With some experiences to reflect on, participants cautioned against future pitfalls such as spurious rigor, doing the wrong things with better information, or allowing needs to take a back seat to misaligned priorities between collaborators. Resource managers – not scientists – need to be heading up projects so that actual demands drive supply (lest the projects result in more climate science "Froot Loops" – a product filling no clear demand that in the end does harm). This dynamic risks placing scientists in a consultancy role, however; it is crucial that they and their respective fields learn from the experience too. The prominence of social scientists in the early stages of co-production have brought it a long way, but the missing piece may now be engineering researchers.

As the co-production field matures, it's important to maintain the integrity of original concepts and ideals and to keep documenting processes to build a coherent body of literature on top of the strong existing foundation (e.g. the "How-To Guide for Co-Production of Actionable Science"). As engagement becomes a more prominent requirement for funding, it risks being turned into an after-the-fact feature rather than a mandate for action.

What's on the horizon? Planning for the future

Presenters: Adam Parris, Jeff Arnold, Kathy Jacobs, David Behar
Moderator: Lisa Dilling

Going forward, participants agreed that the future of climate change adaptation needs to be cross-sectoral; scaling out is as important as scaling up. Achieving cross-sectoral collaboration is an extremely challenging goal, and the other sectors that need to be tapped will be different depending on the region. Though such efforts didn't get far after Hurricane Sandy, the potential seems better now, and the Department of Commerce could be a good resource for making contacts with other industry associations. Also, the business sector needs to be brought into the fold at some point.

Future credibility and funding will come more easily if cost-benefit analyses of action vs. inaction are undertaken, including at different timescales, and this would require characterizing some performance baselines. Assessments, across the board, of both processes and outcomes, need to be frequent/sustained and rigorous in order to have a proactive stance; they build knowledge and relationships and lead to agreement on what is authoritative. If the idea is to engage in activities that improve society, we'll have to be able to measure that; see Jacobs' slides on the goals of the third National Climate Assessment.

Utilities are still in "low-regrets" mode, but in the future will have to make bigger, more difficult decisions. Before that time comes, the industry will need a better understanding of how to make decisions under deep uncertainty. This is one of the areas that warrant a rethinking of which questions to ask. Building on the new questions, a clear statement of goals, a vision, leadership to carry out the vision, and alignment of resources will be necessary for creating a successful climate service. But increasing numbers of actors, including both a federal advisory committee making recommendations to the Secretary of the Interior (ACCCNRS) and a large scale climate service operation in the midst of strategic planning (the Southwest Climate Science Center), have pointed to the urgency – and achievability – of building co-production oriented climate service capacity regionally.

Where should we go? Stitching it all together: Water utilities, climate science, co-production, assessment, adaptation. What should be done?

Panel: Erica Brown, Jeff Arnold, Dan Ferguson, Paul Fleming
Moderator: Gregg Garfin

Sustained collaboration between the federal government and civil society is desirable, but no one is waiting on a federal solution and no one wants a federal prescription. Future PUMA-like activities should begin the process of defining the appropriate federal role in providing adaptation support

through a climate service (keeping in mind that overreliance on politically fickle funding would be unwise). That federal role determination may dovetail with defining the 20% in the 80/20 principle (which theorizes that 80% of the total possible benefits are the result of 20% of the total possible effort); the 20% could include aspects of a climate service that would be common to most/all regions, and those aspects could be scalable (up *and* out).

The first round of PUMA projects set out to demonstrate and study a collaborative modeling process, at which they succeeded. The next steps should build on that success by scoping what a service that supports data-to-decisions would look like. Succeeding at this will require clear statements of purpose and goals from the outset.

A climate service will be built upon a collection of co-production processes. As such, two evaluation metrics will be a) responsiveness to industry needs and b) success in training scientists. The broader goal will be supporting more resilient and prepared communities.

III. BREAKOUT SESSIONS

"Blue Sky" Breakout Session Reports

In the first of two breakout sessions, attendees were divided into four smaller groups and asked to envision a "Blue Sky" utopia – where they could have anything they wanted in a water climate service – and answer three questions:

1) What key functions/elements should a water climate service have?

2) What products does a water climate service need to provide to its clientele?

3) What does success look like?

The report outs featured a number of common themes and shared views and so are organized by theme here rather than individual group reports. The responses have been lightly reorganized to include activities and roles that the water climate service would undertake in the Key Functions, Products, and Measures of Success categories.

Key Functions: activities and roles

Knowledge brokering, connecting, and convening functions: There was broad agreement among groups that the service should act as a broker or go-between connecting user needs to data, tools, skillsets, or relevant experiences of other users. Groups also agreed that the service should be a coordination center, able to minimize duplicative efforts, communicate with external entities (the public, other sectors, governments, and private firms), and perform outreach to prospective collaborators – who may or may not be within either academia or a utility. In connecting entities, the service should facilitate bi-directional knowledge transfer/translation between utilities and experts so that the products and services offered are relevant to needs, and also facilitate the transfer of expertise from larger to smaller utilities. It was noted that in order to achieve the above, the service must have cross-boundary knowledge about decision/planning processes, as well as science and scientific applications, and employ professional facilitators. Two groups referenced a "convening" element, with a focus on physical meetings and workshops to bring actors together periodically or for specific projects.

Research, information, funding, and evaluation functions: All groups said that the service should stay current on relevant research and synthesize findings in order to become a "warehouse" for tools and information, and also to identify emerging issues and future challenges in a timely fashion. Two of the four groups suggested that the service should be able provide incentives for engagement and alignment, e.g. fellowships and/or grants. Two groups mentioned that the service should define metrics through which it can evaluate its own processes, products, and activities during regular assessments. Two groups said fundraising and grant-writing skills would be important to have in-house, and one group said that the service should build visibility (presumably of the necessity and functions of the climate service).

All groups reported that the service should develop and maintain "standards," but there was no clear agreement on the nature or role of the standards: would they be data standards or standardized procedures for applying data? Would they be legally defensible/provide liability protection? Does the

term “standards” imply something beyond best practices? (Clarification on this question is needed in subsequent phases of work.)

All groups mentioned some variant of decision support/mapping/analysis. One group said this aspect should be “tailored and stratified (by scale);” one group suggested an “understanding of decision processes;” another suggested a how-to for decision making under deep uncertainty. This topic in particular straddles the functions vs. products divide.

Products: usable services, data, and tools

All groups reported that the service should provide data and guidance, and that offerings should be based on user needs. Hydroclimate observations/baselines and projections were among the types of data specified as most valuable. All groups mentioned several or all of the following types of guidance: data usage; communicating with scientists; communicating climate data to boards of directors or the public; communicating the value of adaptation vs. the costs (including economic evaluation to the extent possible); and decision support/connecting climate data to actions. This guidance should be available through a mix of self-directed media (fact sheets, videos, etc.) and interactive events (workshops, webinars, etc.). Products and guidance content should be available for both beginners and users with more experience.

Three groups thought that the service should provide regular updates on the state of climate science (and other relevant fields), with one group also suggesting that “consumer reports-style” information be provided along with the data and tool updates. The following specific suggestions for products were offered at least once between the four groups: decision support systems and open-source code; co-production or co-facilitation as a specific service offering; tailored products; a Help Desk/Ask the Expert function; technical support for modeling and data interpretation; relevant climate event alerts; virtual and/or physical space for people to meet (in order to build trust, share ideas, share failures, learn, disagree, collaborate); FAQs; and interactive/customizable climate data visualization tools.

Measures of Success

There were five unanimously-suggested measures of success: 1) effective long-term engagement with decision makers; 2) new or extended networks; 3) incorporation of climate change information into planning/standard practices (“mainstreaming”); 4) defined success metrics (did the service improve utility processes or outcomes?); and 5) continued/sustainable funding.

Three measures were recommended by two or more groups: capacity at multiple scales; ability to demonstrate and learn from successes and failures and to show the derivative benefits of success; and widespread use/attracting users beyond initial group (perpetuation).

These measures were mentioned once among the four groups: evolving products; efficient access to experts and information; utilities knowing their own vulnerabilities and having flexibility in response; demarcation of private sector, local government, and federal government roles; informed private sector (consultants); credible/transparent/legally defensible information; positive influence on regulatory/policy processes; and capacity built into the community, not just within the service.

"Nuts and Bolts" Breakout Session Reports

In the second breakout, attendees reassembled in the same four groups as in the Blue Sky Breakouts to develop ideas on the practical elements of a water climate service pilot project. They were asked to focus on three questions:

1) What is the right geography for a water climate service pilot?
2) What is the right corporate structure and governance for a water climate service pilot?
3) What ballpark level of financial support would be needed to: a) get the pilot off the ground (at about six months of existence/operations); and b) to sustain a mature pilot (at about 3-5 years of existence)? As part of your answer, outline infrastructure/human capital needs. (Not seeking a budget here – just some approximations/ranges).

These reports offered more clearly differentiated visions for a water climate service and so are presented here individually.

Group 1

Reported by Breakout Leader Adam Parris.

Geography: The service's boundaries should not be defined the way those of the RISAs and CSCs have been – it would be best to define pilot boundaries by characteristics (e.g. water sources, management issues) relevant to a set of water utilities because the service is going to be articulated around what they need. It would be best to define boundaries to include the widest area of smaller/more vulnerable utilities within hydroclimate boundaries and serve everyone within that defined region (it will probably include a larger utility, possibly a WUCA utility). Also keep in mind that wherever the offices are physically located will determine who they respond to both geographically and politically.

Structure/Governance: There should be a free-standing governing board and a network of science and service providers. Membership of the board should include intended users/beneficiaries as well as funder(s). The director should be from a utility, and ideally there would be two co-directors: one from a small utility and one from a large utility.

Funding: 30% of budget would be for staff, 20% for operations, and 50% for supporting co-production. The absolute minimum amount of funding would be approximately the RISA level (~$700K/yr), but would be fully functional at $5 million per year. Ideally the funding would be ~$1 million per person and have 6 people with money for travel, workshops, software, etc.

Funding would be public-private; base funds would come from WUCA utilities and other private entities. (Or maybe every utility that gets service from the pilot pays in at the level they're able. The service should be responsive to the utilities and this is easiest if they're funders.) Other funds could come from federal grants (so as not to be tied to any federal governance). It was mentioned that if you don't get federal engagement then you'll be seen as competition and not be supported. UCAR/NCAR and an FFRDC entity was suggested as a model, as was the desirability of staying outside the federal structure in order to be less tied to any specific mandate(s) and not be tied to any one funding stream.

The pilots (undefined number) would be evaluated after 3-5 years, and assuming they were successful, would evolve into something more permanent. Non-profit status would be sought, but would lag behind pilot stage.

Discussion: Can FFRDCs be 501(c)(3)s organizations? These legal nuances need to be researched.

Group 2

Reported by Breakout Leader Gregg Garfin.

Geography: To eliminate geographical limitations and competition with organizations that are already tied to specific regions (and because it's never been done), this group envisions a federation of distributed centers, leveraging existing resources and serving as a "virtual service." This would leverage the trust and relationships built by existing centers, and also reduce any competitive issues with those institutions.

Structure/Governance: WUCA can take a leadership role. The service will grow as needs increase and governance will evolve (form following function). Reference UCAR or UKCIP as examples of a federation approach to developing a service. Public-private partnership; eventually the "virtual service" would coalesce into a 501c3. This would to avoid the difficulty of creating a new agency at the federal level and maintain distance and neutrality between services and funding. This also allows private sector players into the mix more easily.

Funding: $6-$8 million over 3 years.

Discussion: Pilot issue could be how to integrate climate change science into capital planning decisions. Spin up a set of 3-5 pilot projects with different size utilities (mix of large and small). Create a boundary organization in parallel, similar to a RISA. Each project would get ~$1 million over 3 years, plus $1 million/year for boundary the organization's staff (4-5 people). Boundary organization immediately starts building up outreach, communications, education, and capacity, begins convening and evaluating, writing guidance docs and addressing decision support, as well as conduct research on process, boundary organization development, and capacity building. Someone should study the process of growth, which is intended to evolve structurally and functionally.

Group 3

Breakout Leader Dan Ferguson, reported by member Laurna Kaatz.

Geography: regional, 2-3 states max; new model, but similar to existing models that allow for bringing together funds from multiple sources to carry out work (e.g., NCAR or Federally Funded Research and Development Centers or FFRDCs). Not a federal agency.

Funding: $3 million/year (4x RISA funding); public-private partnership – think National Parks Foundation.

Structure/Governance: Not proposing a giant RISA, but RISA offers the best structure of existing examples. We want to offer "middleware" – meet needs between local and federal roles. May want to try to work with existing structures of states. Try to leverage space from some other organization to save money. Governance Principals: The service should serve equitably and allow for equal access to everything. An important goal is to ensure the entity can support vulnerable communities who may have little access to state-of-the-art information, lack human resources, and have limited technical capacity. The service should be transparent. Funders should be represented on the board, but others should be as well (i.e. entities with fewer resources). The framework for the service should be adaptive. Governance should preserve quality of service and also allow for learning and adaptation of services offered. We want to learn by doing. The service should not be too complex or too big to govern, but governance should be reflective of complexity and functions. We want to incentivize collaboration and leverage other agencies (with money, but probably other rewards TBD). The Climate Services Partnership's publication "Ethical Framework for Climate Services" should be referenced.

Group 4

Reported by Breakout Leader Paul Fleming.

Geography: The group didn't settle on one way to define boundaries. Some ideas: 1) geographically defined where there is a tent pole utility – a large, already engaged utility – and a group of smaller utilities in the region of the tent pole utility with related issues/hydrology (this would constitute a "chapter"); 2) issue-defined, e.g. coastal vs. interior vs. snow-driven, etc.; or 3) build around existing structures (e.g. RISAs) to leverage their connections and functions.

Structure/Governance: The group developed a couple of different approaches for structure, focusing primarily on the geographically defined/tent pole utility model. One idea is for each pilot project/chapter of the service to have a ½ time or ¼ time employee housed within a tent-pole utility (the "center" of the chapter), and in each chapter also have a climate service director and staff that cover a range of skillsets (e.g. economic analysis, standards development, data curation, communication, decision support). A slight variation on this structure would be to have some staff housed and focused on one chapter with another set of staff housed in the national office/mothership providing shared services (e.g., economic analysis or valuation approaches) to all chapters in the pilot project. This approach would likely facilitate peer to peer learning within a region, with support from staff expertise in the Climate Service, as well as peer to peer learning across regions provided there were more than one "chapter" initiated.

Another idea would be to have a ¼ time employee at several smaller utilities around the tent pole with liaison staff to create a network for the chapter and have services (like the five listed in the previous idea) housed in a national mothership that coordinates with each chapter.

Funding: $200K/person/year.

Appendix A: Agenda

DAY 1 / MAY 2nd

7:45 AM - 8:30 AM
Registration, hot breakfast buffet

I. INTRODUCTION AND BACKGROUND

8:30 AM - 9:00 AM
Welcome, WUCA, Overview of the Workshop, Workshop Goals, Flow, and Vision
PRESENTER: David Behar, San Francisco Public Utilities Commission, Workshop Chair

II. THE PUMA PROJECT

9:00 AM - 9:15 AM
Overview of the PUMA project

PRESENTER: Paul Fleming, Seattle Public Utilities

9:15 AM - 10:15 AM
PUMA Project: Portland Water Bureau

PRESENTERS: Edward Campbell, Portland Water Bureau, Katherine Hegewisch, University of Idaho, Julie Vano, National Center for Atmospheric Research

10:15 AM - 10:30 AM
BREAK

10:30 AM - 11:15 AM
PUMA Project: Seattle Public Utilities

PRESENTERS: Paul Fleming, Seattle Public Utilities, Phil Mote, Oregon State University

11:15 AM - 11:45 AM
Another WUCA Experience: Denver Water

PRESENTERS: Laurna Kaatz, Denver Water David Yates, NCAR

11:45 AM - 12:15 PM
Synthesis Panel and Plenary Discussion #1

PANEL: Martyn Clark, Bets McNie, James Arnott

MODERATOR: Mohammed Mahmoud, Central Arizona Project

12:15 PM - 1:15 PM
LUNCH

1:15 PM - 2:00 PM
PUMA Project: New York City Department of Environmental Protection

PRESENTERS: Alan Cohn, NYC Department of Environmental Protection, Allan Frei, City University of New York

2:00 PM - 2:45 PM
PUMA Project: Tampa Bay Water

PRESENTERS: Tirusew Asefa, Tampa Bay Water Wendy Graham, University of Florida

2:45 PM - 3:05 PM
Another Water Supplier Experience: Colorado River Basin Study: Moving Forward

PRESENTER: Jim Prairie, US Bureau of Reclamation

3:05 PM - 3:20 PM
BREAK

3:20 PM - 3:50 PM
Synthesis Panel and Plenary Discussion #2

PANEL: Lisa Dilling, Casey Brown, Joe Barsugli

MODERATOR: Brandon Goshi, Metropolitan Water District of Southern California

3:50 PM - 4:00 PM
Sum up PUMA, lessons learned

PRESENTER: Tirusew Asefa, Tampa Bay Water

III. PUMA IN THE LARGER CONTEXT

4:00 PM - 4:45 PM
Panel and Plenary Conversation #3:
What do today's presentations teach us about principles of climate services, co-production, and boundary spanning — in particular for the water sector?

PANEL: Richard Moss, Dan Ferguson, Edward Campbell, Bets McNie, Guy Brasseur

MODERATOR: Adam Parris

4:45 PM - 5:00 PM
Sum up, Final wrap up comments, plan for next day, instructions for reception

PRESENTER: David Behar, San Francisco Public Utilities Commission, Workshop Chair

6:00 PM
Reception with Appetizers, No-host bar
The North End at 4580, 4580 Broadway, Boulder (a few blocks from hotel)

DAY 2 / MAY 3rd

7:45 AM - 8:30 AM
Hot Breakfast Buffet

8:30 AM - 8:40 AM
Welcome, Goals for the Day

PRESENTER: David Behar, San Francisco Public Utilities Commission

IV. CLIMATE SERVICES LANDSCAPE

8:40 AM - 9:25 AM
Where Have We Been?
The climate services institutional landscape
Missions and approaches, distinguishing features, supply and demand, success stories and challenges.

PANEL: Gregg Garfin, University of Arizona Phil Mote, Oregon State University, Roger Pulwarty, NOAA, Guy Brasseur, Max Planck Institute for Meteorology

MODERATOR: Bets McNie, University of Colorado, Boulder

9:25 AM - 9:55 AM
Where Are We Now?
Information for Building Climate Resilience: Opportunities for Public/Private Collaboration

PANEL: Joe Thompson, Government Accountability Office, John Nordgren, Climate Resilience Fund

9:55 AM - 10:40 AM
What's On The Horizon?
Planning for the Future

- "The Future of Usable Science and Boundary Work" Project
- Coordination of climate science for society across federal agencies
- Actionable Science and Sustained Assessment
- Advisory Committee on Climate Change and Natural Resource Science: Recommendations to Secy of Interior and co-production "How to Guide"

PANEL: Adam Parris, Science and Resilience Institute at Jamaica Bay, Jeff Arnold, US Army Corps of Engineers, Kathy Jacobs, Center for Climate Adaptation Science and Solutions David Behar, San Francisco Public Utilities Commission

MODERATOR: Lisa Dilling, University of Colorado, Boulder

10:40 AM - 10:55 AM
BREAK

V. BREAKOUTS - PUTTING IT ALL TOGETHER

10:55 AM - 11:40 AM
Where Should We Go?
Stitching it all together: Water Utilities, Climate Science, Co-Production, Assessment, Adaptation
What Should Be Done?

PANEL AND PLENARY: Erica Brown, Association of Metropolitan Water Agencies, Jeff Arnold, US Army Corps of Engineers, Dan Ferguson, CLIMAS Paul Fleming, Seattle Public Utilities

MODERATOR: Gregg Garfin, University of Arizona

11:40 AM - 11:55 PM
Breakouts - Vision and Plan

PLENARY INSTRUCTIONS: David Behar

11:55 PM - 12:15 PM
WORKING LUNCH
Get Lunch, bring to breakout rooms for working lunch

12:15 PM - 1:30 PM
BLUE SKY BREAKOUT
Envisioning the nature of a water climate service
4 breakouts

1:30 PM - 2:15 PM
Reports back from Blue Sky Breakouts
4 reports at 8 mins each + 13 for discussion

2:15 PM - 2:30 PM
BREAK

2:30 PM - 3:45 PM
NUTS AND BOLTS BREAKOUT
Brainstorming some practical elements of a water climate service pilot project 4 breakouts (same membership as Blue Sky Breakout)

3:45 PM - 4:30 PM
Reports back from Nuts and Bolts Breakouts
4 reports at 8 mins each + 13 for discussion

4:30 PM - 5:00 PM
Wrap up, Next Steps, Adjourn

Appendix B: Attendees

Ammann, Caspar
University Corporation for Atmospheric Research

Armstrong, Thomas
Madison River Group, LLC

Arnold, Jeff
US Army Corps of Engineers

Arnott, James
University of Michigan School of Natural Resources & Environment

Asefa, Tirusew
Tampa Bay Water

Barsugli, Joseph
University of Colorado, Boulder

Bednarek, Angela
The Pew Charitable Trusts

Behar, David
San Francisco Public Utilities Commission

Beller-Simms, Nancy
National Oceanographic and Atmospheric Administraion

Brasseur, Guy
Max Planck Institute of Meteorology

Brekke, Levi
Bureau of Reclamation

Brooks, Keely
Southern Nevada Water Authority

Brown, Casey
University of Massachusetts

Brown, Erica
Association of Metropolitan Water Agencies

Buja, Lauren
Metropolitan State University of Denver

Buja, Lawrence
National Center for Atmospheric Research

Campbell, Edward
Portland Water Bureau

Clark, Martyn
National Center for Atmospheric Research

Cohn, Alan
New York City Department of Environmental Protection

Dilling, Lisa
Western Water Assessment

Dufour, Alexis
San Francisco Public Utilities Commission

Ferguson, Dan
University of Arizona

Fleming, Paul
Seattle Public Utilities

Frei, Allan
CUNY/Hunter

Garfin, Gregg
University of Arizona

Gerling, Alex
American Water Works Association

Goshi, Brandon
Metropolitan Water District of Southern California

Graham, Wendy
University of Florida

Groves, David
RAND

Hegewisch, Katherine
University of Idaho

Iott, Susan
Government Accountability Office

Jacobs, Kathy
University of Arizona

Johnson, Jeffrey
Southern Nevada Water Authority

Kaatz, Laurna
Denver Water

Kao, Shih-Chieh
Oak Ridge National Laboratory

Kirchhoff, Christine
University of Connecticut

Mahmoud, Mohammed
Central Arizona Project

McCarthy, Jennifer
Metropolitan Water District of Southern California

McNie, Elizabeth 'Bets'
University of Colorado, Boulder

Miller, Andy
US EPA

Moss, Richard
PNNL

Mote, Philip
Oregon State University

Nordgren, John
Climate Resilience Fund

Pandya, Raj
American Geophysical Union

Parris, Adam
Science and Resilience Institute at Jamaica Bay

Pendergrass, Angie
University of Colorado, Boulder

Pulwarty, Roger
NOAA

Sharp, Darrin
Oregon Climate Change Research Institute

Smith, Rebecca
University of Colorado Boulder

Taylor, Jeffrey
Aspen Global Change Institute

Ternieden, Claudio
Water Environment Federation

Thompson, Joe
Government Accountability Office

Udall, Brad
Colorado State University

Vano, Julie
National Center for Atmospheric Research

Yates, David
National Center for Atmospheric Research