

A Toolkit for User Engagement



NWS Water
Resources
Workshop

Kevin Werner, CBRFC

Kristen Averyt, WWA

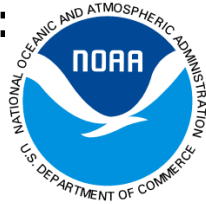
Gigi Owen, CLIMAS

August 4, 2010

Motivation

Forecasts:

- Weather
- Climate
- Water



Water Management: agencies responsible for delivering, allocating, or treating fresh water.

Examples:

- USBR
- Metropolitan Water District
- Colorado River Commission

Photo: Lake Powell, January 2010

Water and Climate

Economics

- Decision making in water resources is big money – especially in the west
- NRCS recently assessed the value of water supply forecasts alone to be far in excess of the cost of the forecast program (Nelson, 2009)
- INFORMS research project in CA: Forecasts – both climate and streamflow - can improve reservoir operations.

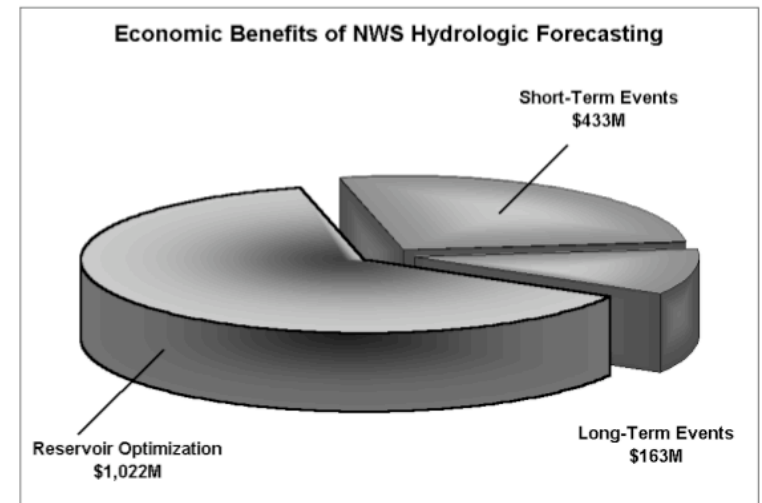


Figure 2. Average Annual Flood Loss Benefits from NWS Hydrologic Forecasts
(Dollars in Millions, indexed to 2000 price level)

Source: NHWC, 2002

Climate & Decision-Making

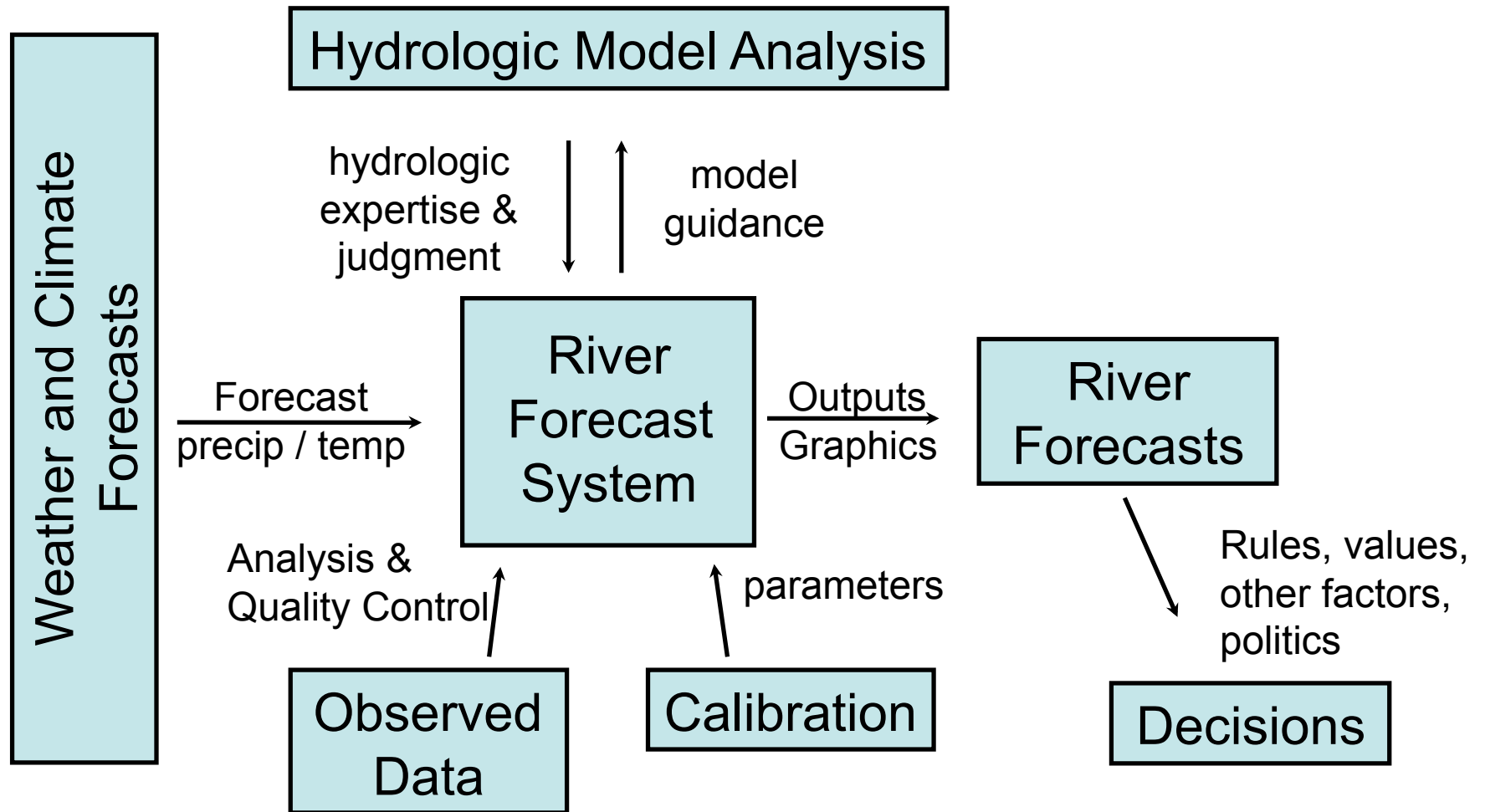
Weather versus climate

- Some lessons transferable, but additional challenges related to use of climate information
- Time scales of climate create less opportunities for validation and to generate trust in forecasts
- Uncertainty associated with the models and with the decision-making process
- Models aren't going to get much better any time soon, so investigating ways to reduce uncertainty and build trust in information through decision making

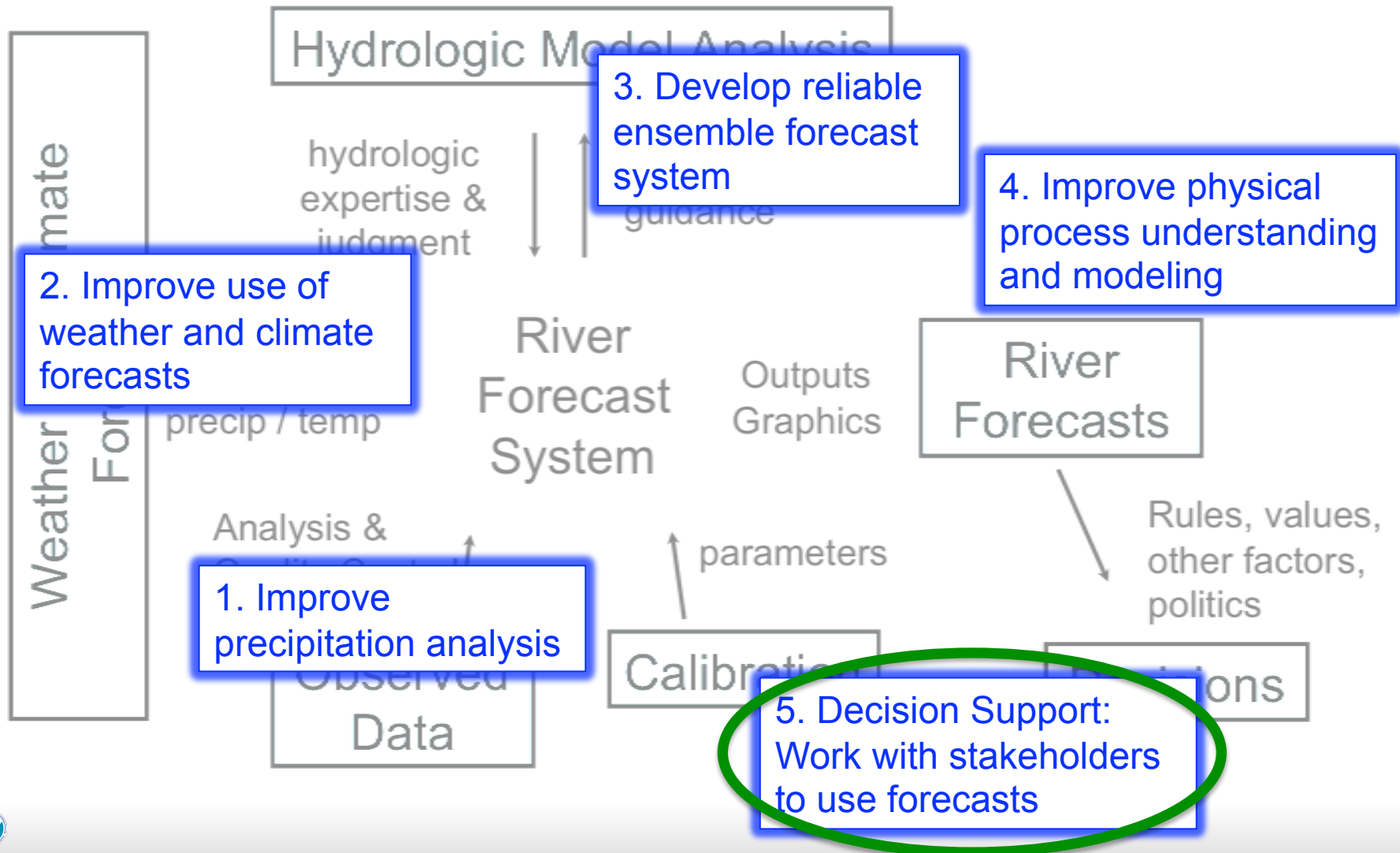


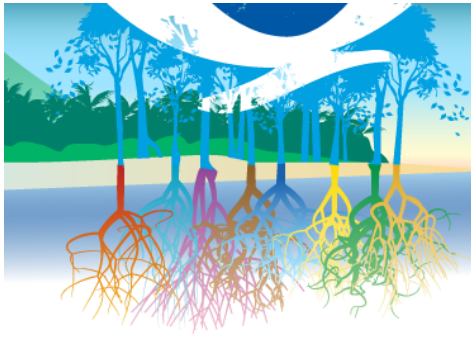
Many federal entities are now REQUIRED to include climate change information in their planning and management strategies
e.g. National Park Service, US Forest Service

RFC Operations



Research Needs





Useless Science?

Google search “useless science” returns 11,400,000 hits

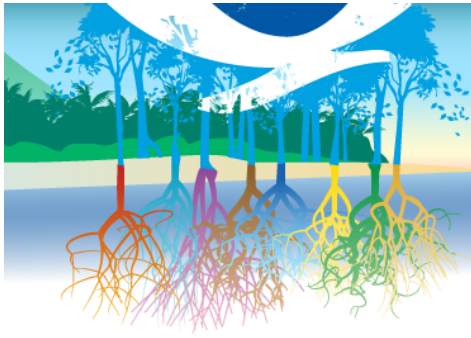
Sample hits:

- Every year about 98% of the atoms in your body are replaced
- If the world were tilted one degree more, the planet would be inhabitable to humans
- Dirty snow melts faster than clean

Are forecasts useless?

MCHUMOR.com by T. McCracken





Previous Research

Forecasts generally not used. Water management agencies value reliability and quality above all else. Unless those are threatened, agencies have little incentive to use forecasts.

Forecast use correlates with perceived risk. Forecast usage not dependent on agency size or on understanding of forecast skill and reliability.

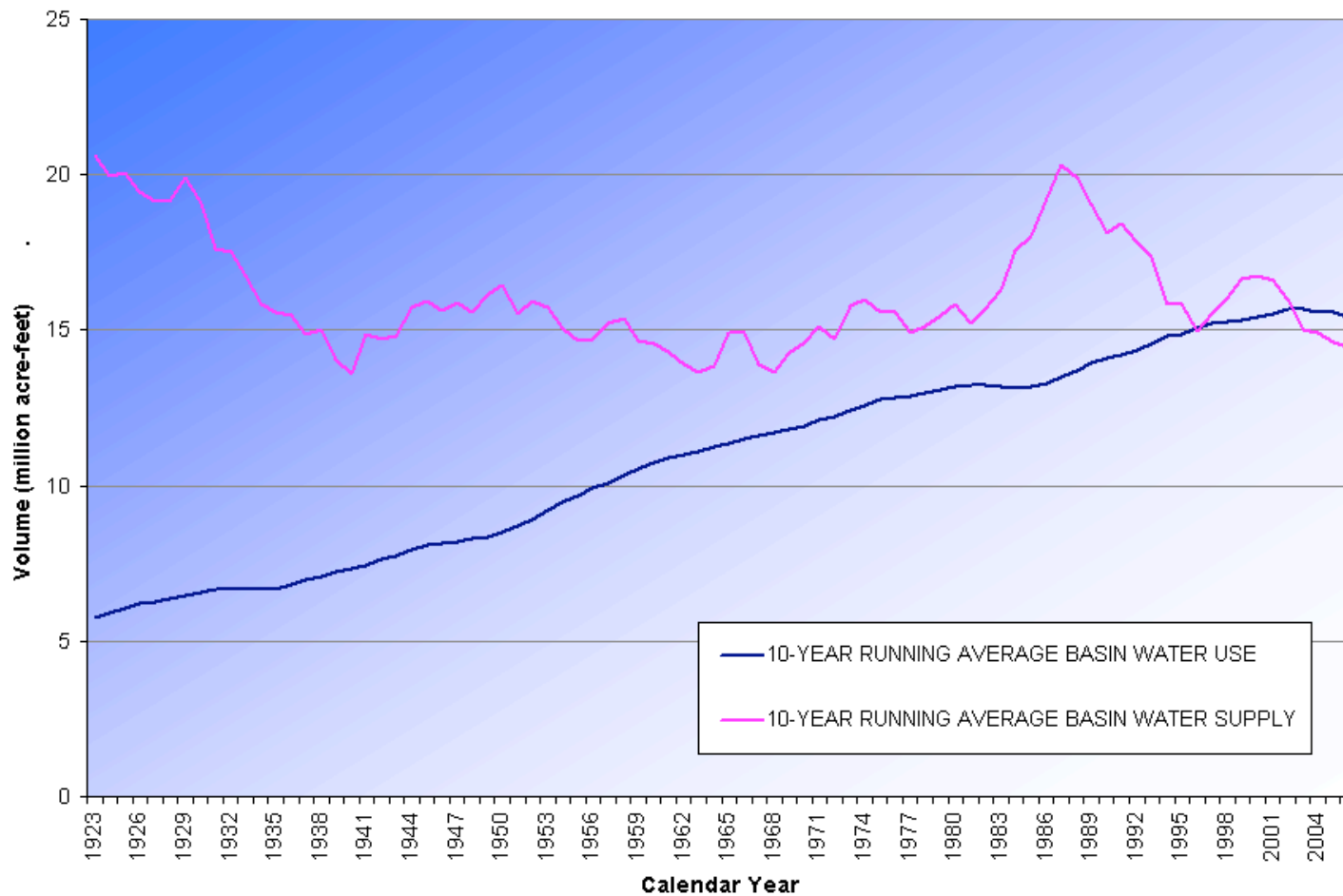
Policy and infrastructure in USA limit use of forecasts. Many operating decisions are tied to observed data and do not allow flexibility.

Hopeless?

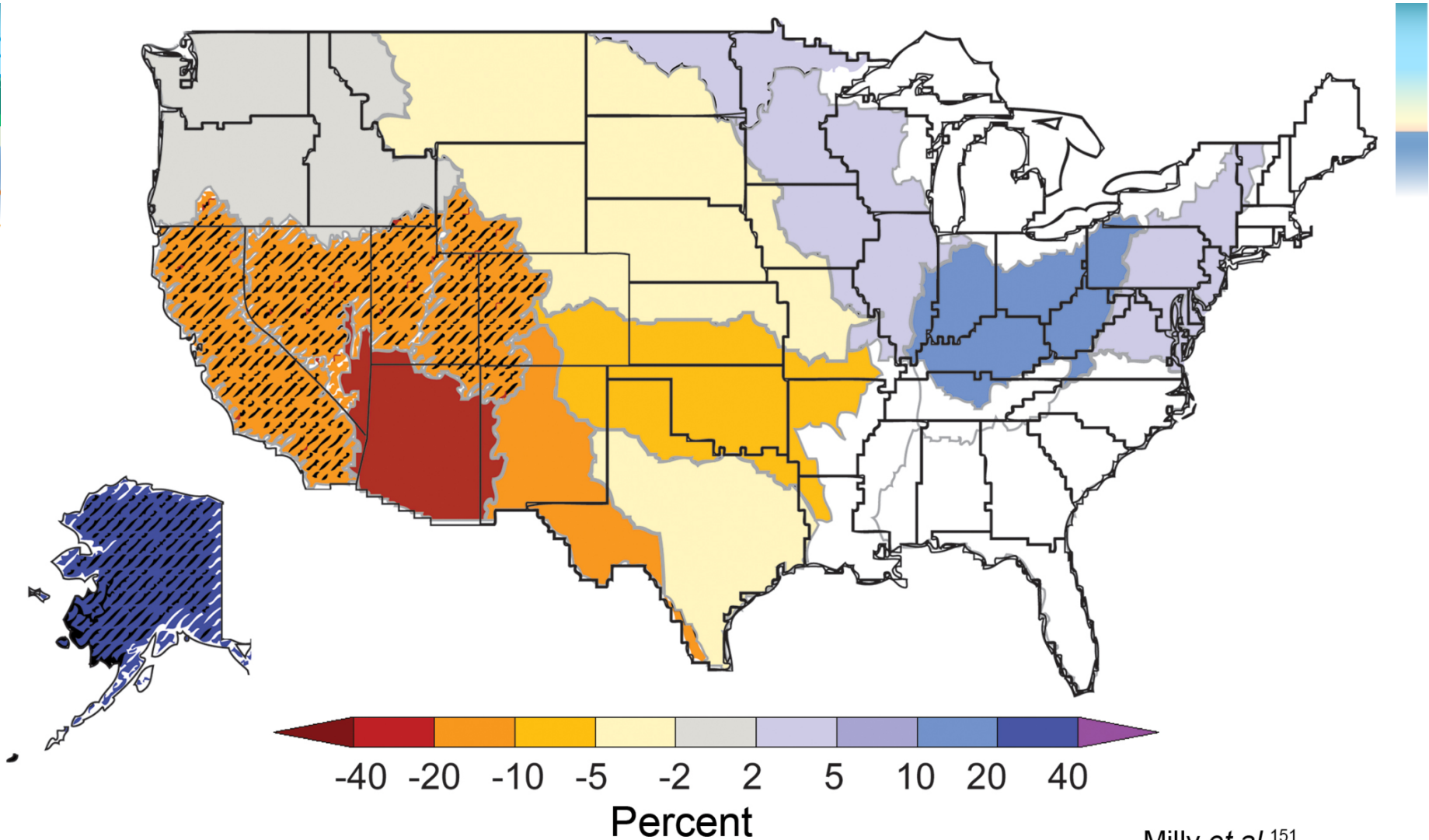
No! Long term drought, increasing demands, and climate change projections for less water each present opportunities for increasing forecast usage.

Study	Method(s)	Geographic Area(s)
(Rayner et al., 2005)	Field Research: Semi-structured Interviews	USA: Pacific Northwest, Southern California, and Washington, DC
(O'Connor et al., 2005)	Survey	USA: South Carolina and Susquehanna River Basin of Pennsylvania
(Lemos, 2008)	Field Research: Observation of Meetings	USA and Brazil
(Dow et al., 2007)	Survey (building on earlier work (O'Connor et al., 2005))	USA: South Carolina and Susquehanna River Basin of Pennsylvania
(Callahan & Miles, 1999)	Field Research: Semi-structured interviews	USA: Pacific Northwest
(Ziervogel et al., 2010)	Case Study	South Africa
(Pulwarty & Redmond, 1997)	Field Research: Semi-structured interviews	USA: Pacific Northwest

Colorado River Supply and Demand



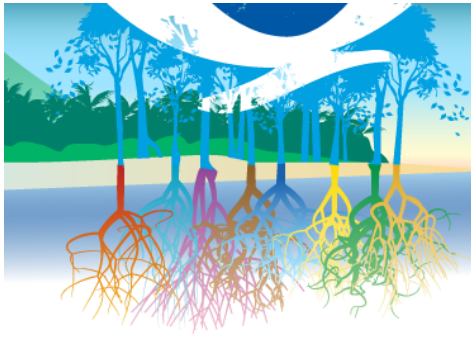
Credit: USBR



Milly *et al.*¹⁵¹

Projected changes in median runoff for 2041-2060, relative to a 1901-1970 baseline, are mapped by water-resource region. Colors indicate percentage changes in runoff. Hatched areas indicate greater confidence due to strong agreement among model projections. White areas indicate divergence among model projections. Results are based on emissions in between the lower and higher emissions scenarios.⁹¹

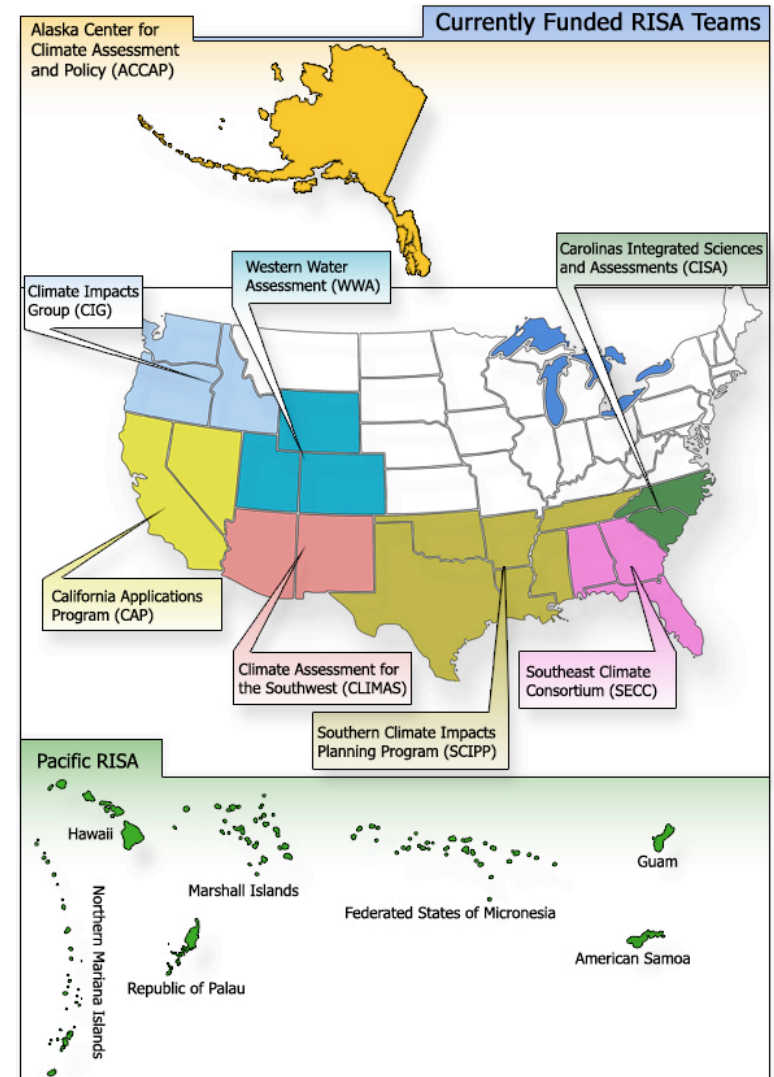


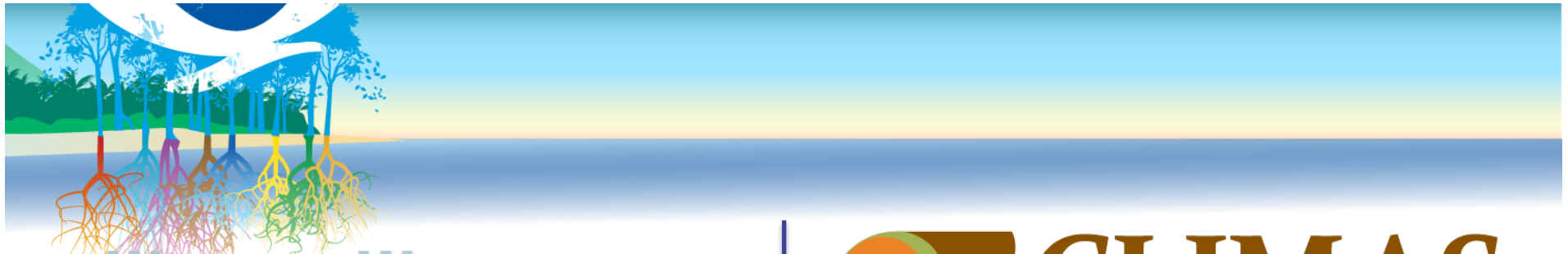


Working With RISAs

Regional Integrated Sciences and Assessments:

- NOAA funded entities, est. 1995
- Expanded to 11 regional programs
- Apply (climate) science to real world problems
- Diverse expertise including natural and social sciences
- Focus on building lasting stakeholder partnerships and supporting decision-making in the face of climate variability and change





WESTERN WATER ASSESSMENT

To identify and characterize regional vulnerabilities to, and impacts of, climate variability and change, and to develop information, products, and processes that assist decision-makers throughout Colorado, Utah, and Wyoming.



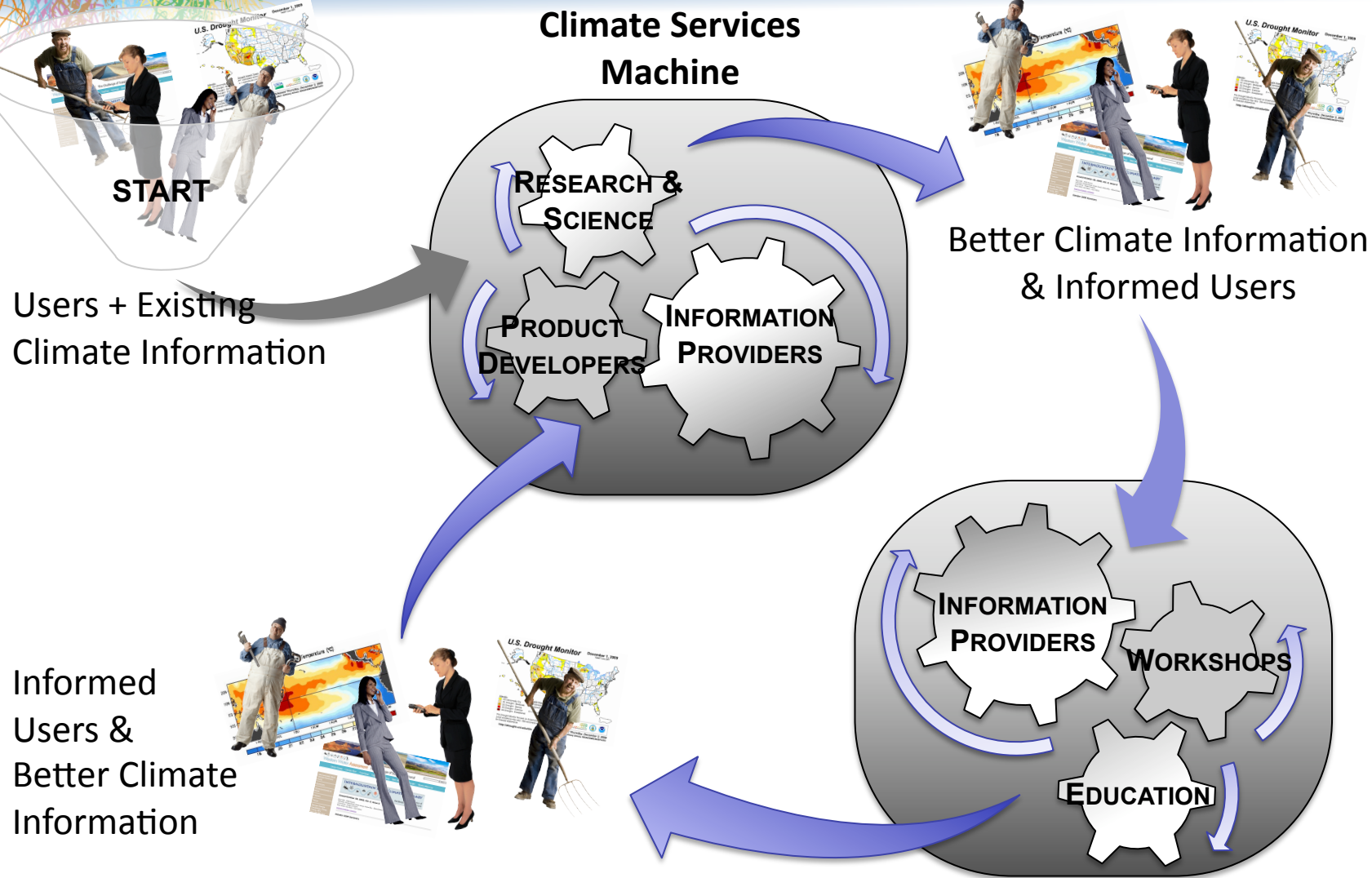
To assess the impacts of climate variability and longer-term climate change on human and natural systems in the Southwest. Our mission is to improve the ability of the region to respond sufficiently and appropriately to climatic events and climate changes.



In the West, many of the impacts of climate change will be delivered through changes in the hydrologic cycle



Climate Services: Integrated and Iterative



Water Supply Verification Workshop

- ✓ Feb 2008
- ✓ Convened by Western Water Assessment, NWS, and NRCS
- ✓ Full day workshop in Boulder, CO
- ✓ Lab exercise with western water web application
- ✓ 60+ attendees including water managers, academics, forecasters, etc.

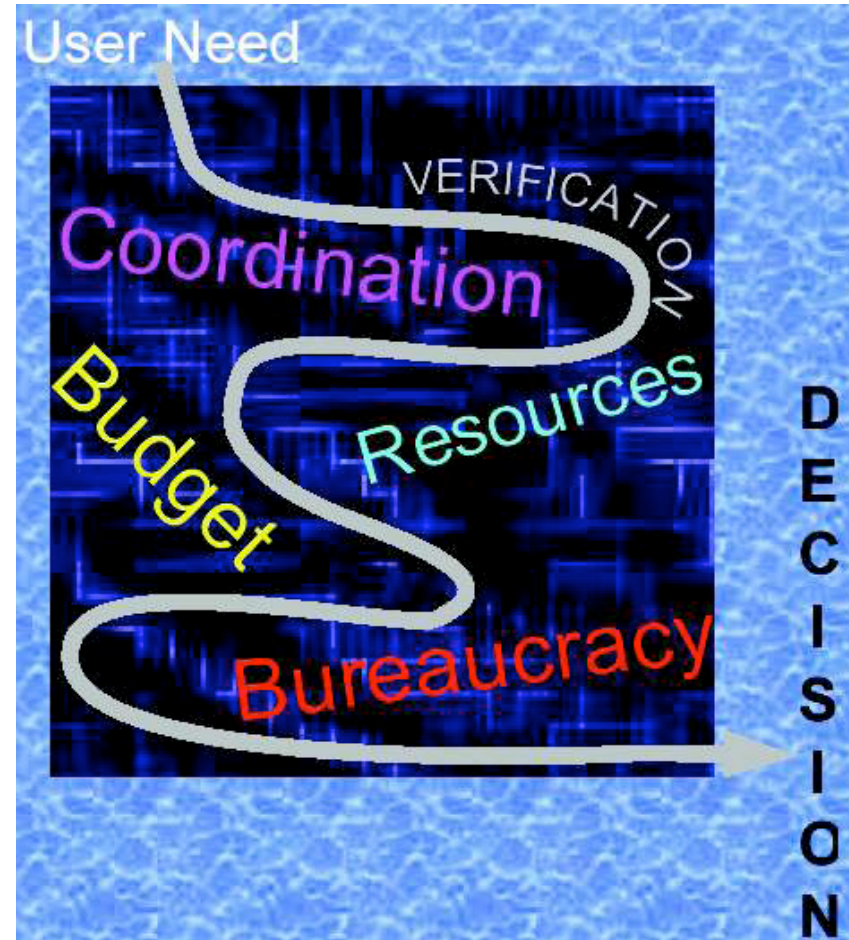
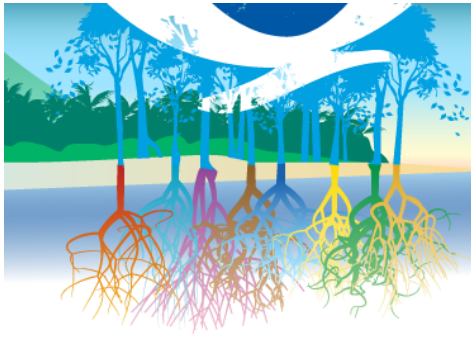
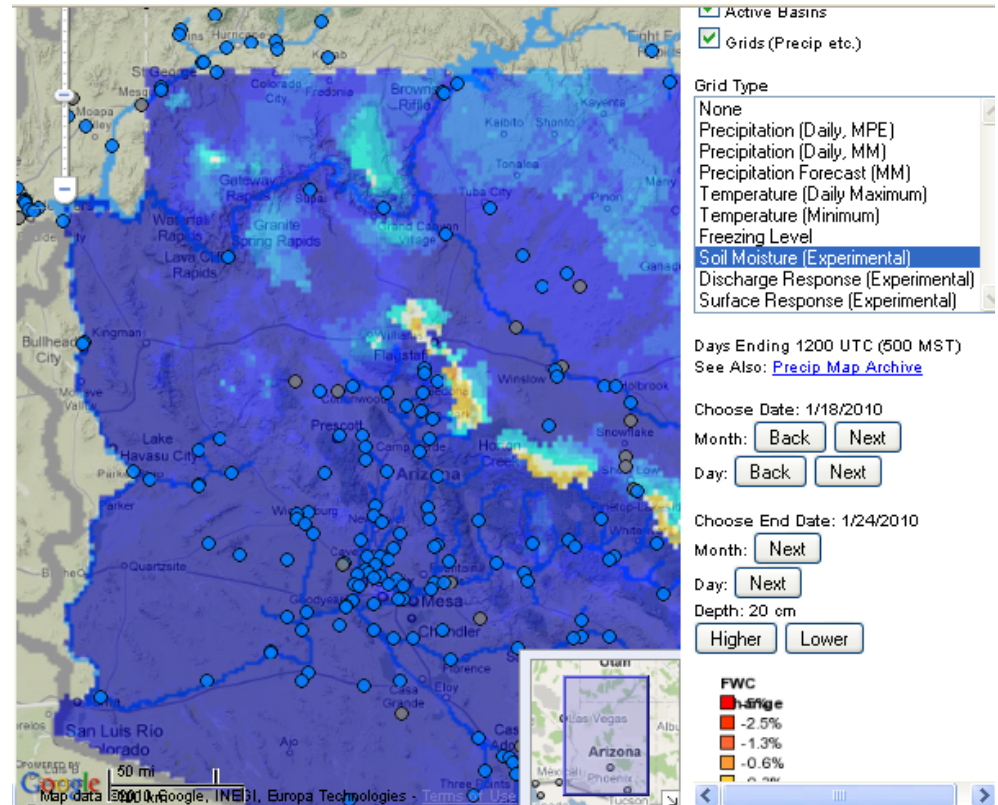


Figure: credit Edwin Welles, NWS



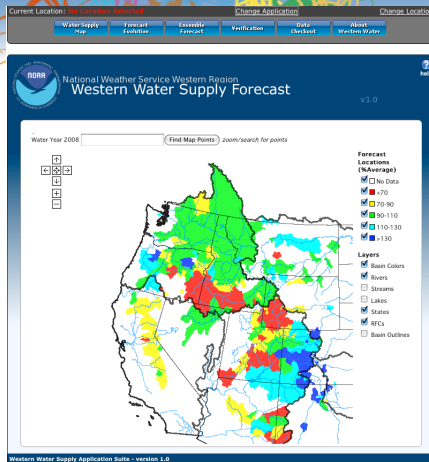
Soil Moisture Focus Group

- ☑ May 2009
- ☑ Co-convened by CLIMAS and CBRFC
- ☑ Half day workshop in Tucson, AZ
- ☑ Presentation, discussion, lab based on CBRFC distributed model project
- ☑ Project in early stages of development
- ☑ Structured feedback
- ☑ ~10 invited participants

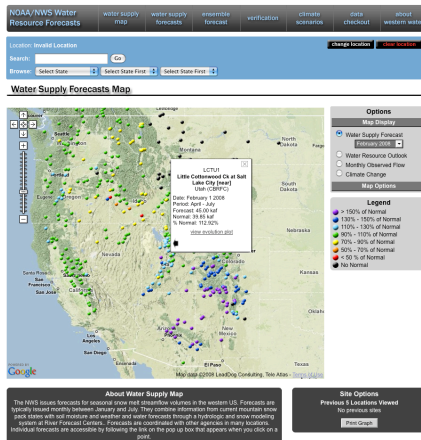


lat: 35.17 lng: -112.37, 7. Data from Tue, 18 May 2010 15:43:04 -0600
 Get the Old Map or Give Feedback on New Map

NWS Western Water Supply / Water Resources Outlook



2008 (version 2)



2009 (version 3)

National Weather Service National Water Resources Outlook

Home Maps Points Help

Welcome Search for a Point About Website

Welcome to the National Water Resources Outlook

Notice! This is an Experimental Product.

Water is an important resource for agriculture, industry, cities, and people all across America. The National Weather Service forecasts streamflow for many rivers around the country to support decision making related to water management. In times of excess, flooding can be planned for or mitigated based on forecasts. In times of scarcity, water can be managed to maximize its value based on forecasts. This site provides access to river forecasts and a variety of visualization tools. Suggestions and comments on this website and NWS water resources forecast services are always welcome.

Currently Participating River Forecast Centers:

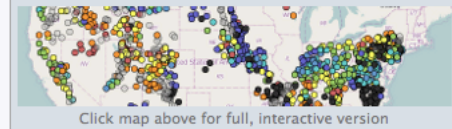
Alaska/Pacific RFC Arkansas-Red Basin RFC California-Nevada RFC
 Colorado Basin RFC Lower Mississippi RFC Middle Atlantic RFC
 Missouri River Basin RFC North-Central RFC Northeast RFC
 Northwest RFC Ohio RFC Southeast RFC West Gulf RFC

Three Ways to Get Started:

Hydrologic Point Information

Search by River, Location, or Handbook-Five ID

National Water Resources Map



Click map above for full, interactive version

Western US Water Supply Map



Click map above for full, interactive version

2010 (version 4): wateroutlook.nwrffc.noaa.gov





Water Resources Outlook Meeting

Park City, UT – July 2009

- ☑ Web developers
- ☑ RFC outreach people
- ☑ RFC management people
- ☑ Handpicked from all over the U.S.

What did RFC folks want to know?

- Who are their users?
- What are their needs?
- How are they using RFC products?
- How can the RFC products better fit their needs?
- How can the RFC market the products to NEW user groups?



Toolkit for User Engagement

Toolkit of combined social science methods to help RFC folks answer these questions about forecast use...

- Surveys
- Trainings
- Focus groups
- Interviews
- Interactive games

With examples from our case study regarding a specific RFC product – the Water Resources Outlook



Pilot Tests

November 17–19, 2009: Boulder, CO

Introduce USFS hydrologists to recent climate information and the array of climate-related tools, products, and data available

March 2010: Salt Lake City, UT

Dry run of all instruments for our first stakeholder workshop

WWA Funding: September 2009–July 2010
Leveraged Funding: USFS





NWS River Forecast Center

April 23, 2010: Grand Junction, CO

Introduce and evaluate the new national Water Resource Outlook web-based tool developed by the CBRFC

- **Climate Literacy and Background Survey**
 - (Pre- and Post-Workshop)
- **Computer-based usability evaluation**
- **Scenario Exercises**
 - Used to evaluate how the tool might be used & what information people use to make decisions

WWA Funding: July 2009–onward
Leveraged Funding: NOAA NWS
CBRFC



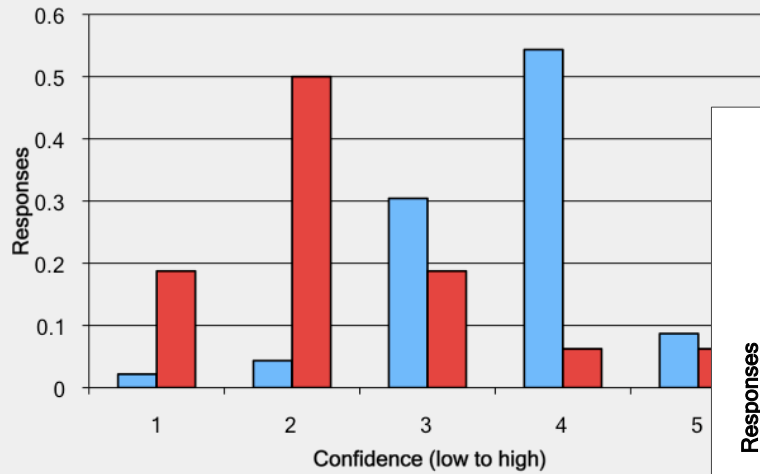


Climate Literacy & Background Survey

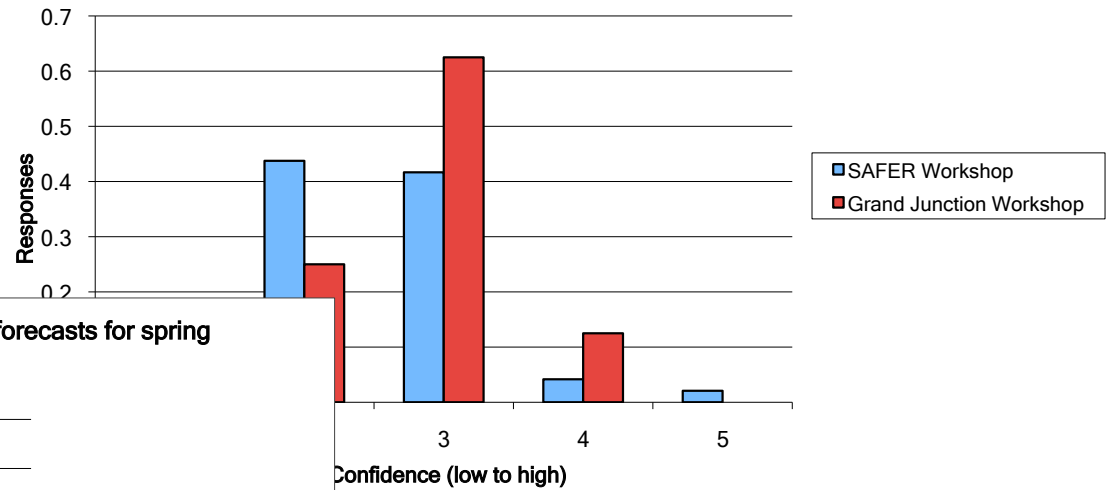
- 35+ Questions
 - Demographic Information
 - Familiarity about sources of climate & water information
 - Perceptions about climate & water forecasts (based on “Feeling at Risk Matters: Water Managers and the Decision to Use Forecasts,” O’Connor et al, 2005)
 - Test of basic climate concepts

Survey Results

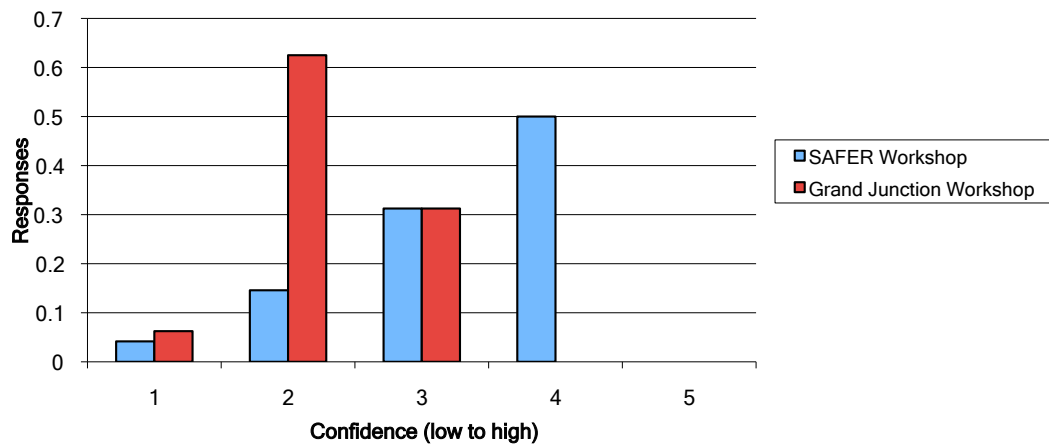
Confidence in predictions about water for the next five days

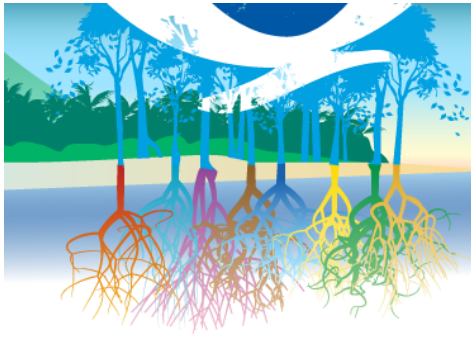


Confidence in temperature and precipitation forecasts for next 3 months

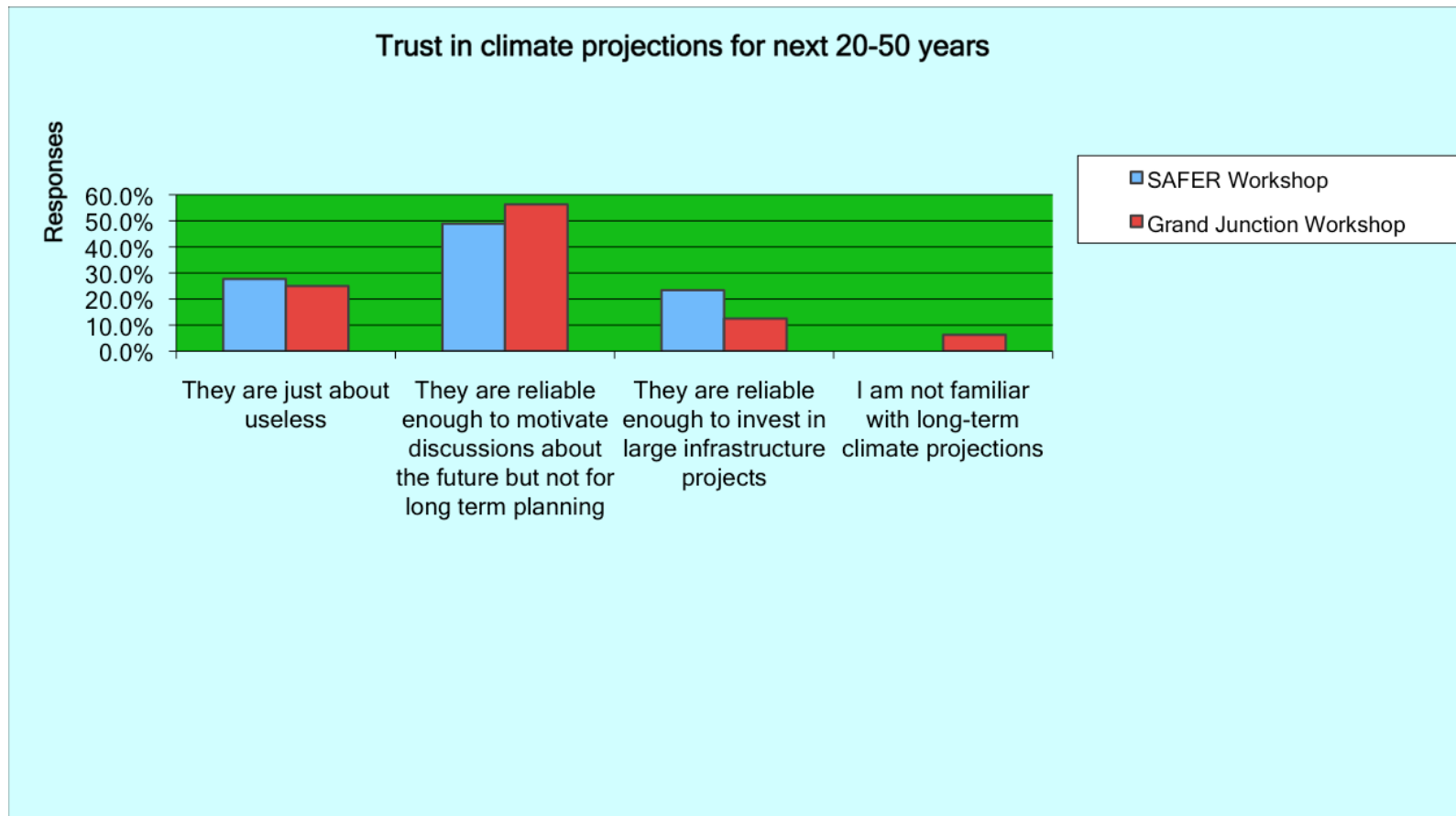


Confidence in seasonal streamflow and water supply forecasts for spring runoff period





Survey Results



A decorative banner at the top of the slide. On the left, there are stylized trees with colorful trunks (red, purple, brown, yellow, green) and roots extending into a blue water body. The background of the banner is a gradient from light blue to yellow to light blue.

Usability Survey

- 37+ Questions
 - Complete a series of tasks using all different aspects of the Water Resources Outlook
 - Feedback on how to improve the tool
 - How it looks and ease of use
 - Practical applications to different lines of work
- Two way information exchange



Decision Games & Scenarios

- **Six Scenarios**

- Three about water management
- Three about recreation management

- **Time Scales**

- Monthly forecast
- Seasonal forecast (1-3 months)
- Very long term (25-50 years)

- **Purpose**

- How people process visual representations of streamflow forecasts
- How people use it to make a decision

Scenarios

River Summary Gunnison River near Gunnison Grand Junction, Colorado (GJNC2 / CBRFC)

Seasonal Water Supply Forecast Forecast Period: Apr-Jul [Need Help?](#)

1200 kaf 50% Exceedence (Official Forecast)	84.6% of Historical Median	76.9% of Historical Mean	Location Overview
---	--------------------------------------	------------------------------------	-----------------------------------

Forecast Issued: May 1 2010

980 kaf
90% Exceedence

Forecast Issued: May 1 2010

Seasonal Ensemble Outlook

1110 kaf
50% Exceedence

863 kaf
90% Exceedence

Forecast Issued: Mar 24 2010

Monthly Ensemble Outlook

90% Chance of Exceedence

345.9 kaf **391.7 kaf**

Forecast Issued: Apr 28 2010

90% Chance of Exceedence

River Summary Virgin River at Virgin Littlefield, Arizona (VLTA3 / CBRFC)

Seasonal Water Supply Forecast Forecast Period: Apr-Jul [Need Help?](#)

78 kaf 50% Exceedence (Official Forecast)	217.2% of Historical Median	105.4% of Historical Mean	Location Overview
---	---------------------------------------	-------------------------------------	-----------------------------------

Forecast Issued: May 1 2010

63 kaf **95 kaf**
90% Exceedence 10% Exceedence

Forecast Issued: May 1 2010

Seasonal Ensemble Outlook

49 kaf
50% Exceedence

38 kaf **77 kaf**
90% Exceedence 10% Exceedence

Forecast Issued: Mar 24 2010

Monthly Ensemble Outlook

90% Chance of Exceedence

23.1 kaf **28.4 kaf**

Forecast Issued: Apr 30 2010

River Summary Price River near Price Scofield Res, Scofield, Utah (SFSU1 / CBRFC)

Seasonal Water Supply Forecast Forecast Period: Apr-Jul [Need Help?](#)

25 kaf 50% Exceedence (Official Forecast)	75.8% of Historical Median	54.3% of Historical Mean	Location Overview
18.9 kaf 90% Exceedence	33 kaf 10% Exceedence	34th of 52 Official Historical Flows	

Forecast Issued: May 1 2010 [View Water Supply Forecast Plot](#)

Seasonal Ensemble Outlook Forecast Period: Apr-Jul

23 kaf 50% Exceedence	69.1% of Historical Median	51.8% of Historical Mean
17 kaf 90% Exceedence	35 kaf 10% Exceedence	

Forecast Issued: Mar 24 2010 [View Seasonal Ensemble Outlook Plot](#)

Monthly Ensemble Outlook Month:

90% Chance of Exceedence	50% Chance of Exceedence		10% Chance of Exceedence
9.2 kaf	11.2 kaf	56.3% of historical median	49.5% of historical mean
			14.5 kaf

Forecast Issued: Apr 28 2010 [View Ensemble Prediction Plot](#)

Location Overview

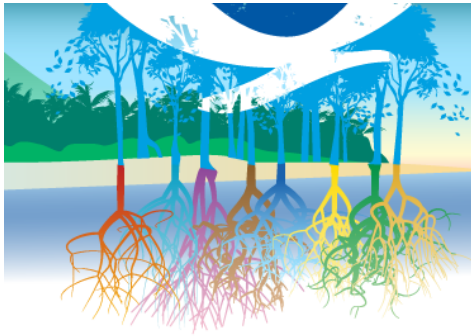
[Zoom To Location On National Water Resources Map](#)
[Western US Water Supply Map](#)

Nearby Points

- [White River near White Tabbyune Ck. Soldier Summit \(WRSU1\)](#) 12 miles
- [Gooseberry Creek near Gooseberry Ck Scofield \(GOSU1\)](#) 17 miles
- [Huntington Creek at Huntington Ck Electric Lake \(ELLU1\)](#) 22 miles
- [Pleasant Creek near Pleasant Ck Mt Pleasant \(PLEU1\)](#) 34 miles
- [Strawberry River near Strawberry Soldier Springs \(SOLU1\)](#) 39 miles



Scenarios



Seasonal Water Supply Forecast ?

Forecast Period: Apr-Jul

[Need Help?](#)

25 kaf 50% Exceedence (Official Forecast)		75.8% of Historical Median	54.3% of Historical Mean
18.9 kaf 90% Exceedence	33 kaf 10% Exceedence	34th of 52 Official Historical Flows	

Forecast Issued: May 1 2010 [View Water Supply Forecast Plot](#)

Seasonal Ensemble Outlook ?

Forecast Period: Apr-Jul

23 kaf 50% Exceedence		69.1% of Historical Median	51.8% of Historical Mean
17 kaf 90% Exceedence	35 kaf 10% Exceedence		

Forecast Issued: Mar 24 2010 [View Seasonal Ensemble Outlook Plot](#)

Monthly Ensemble Outlook

Month: May 2010

90% Chance of Exceedence	50% Chance of Exceedence	50% Chance of Exceedence	10% Chance of Exceedence
9.2 kaf	11.2 kaf	56.3% of historical media	49.5% of historical mean
		14.5 kaf	

Forecast Issued: Apr 28 2010 [View Ensemble Prediction Plot](#)

Location Overview

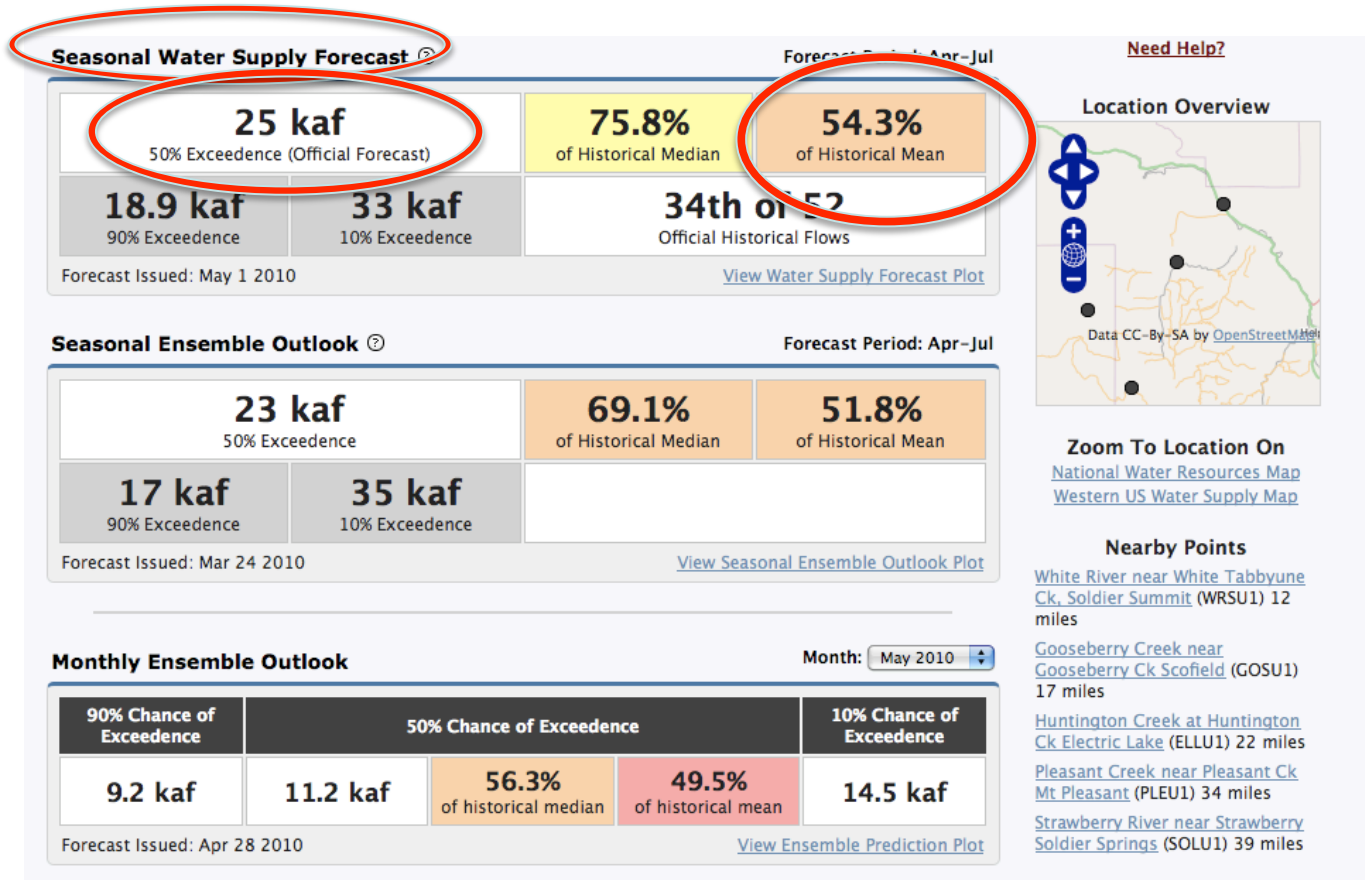
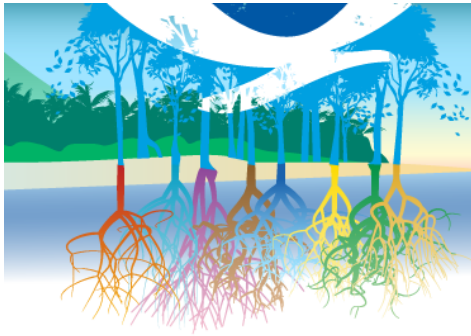
Data CC-BY-SA by [OpenStreetMap](#)

Zoom To Location On
[National Water Resources Map](#)
[Western US Water Supply Map](#)

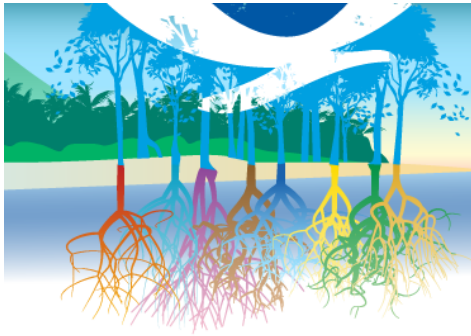
Nearby Points

- [White River near White Tabbyune Ck, Soldier Summit \(WRSU1\)](#) 12 miles
- [Gooseberry Creek near Gooseberry Ck Scofield \(GOSU1\)](#) 17 miles
- [Huntington Creek at Huntington Ck Electric Lake \(ELLU1\)](#) 22 miles
- [Pleasant Creek near Pleasant Ck Mt Pleasant \(PLEU1\)](#) 34 miles
- [Strawberry River near Strawberry Soldier Springs \(SOLU1\)](#) 39 miles

Scenarios



Scenarios



River Summary Virgin River at Virgin Littlefield, Arizona (VLTA3 / CBRFC)

Seasonal Water Supply Forecast ?

Forecast Period: Apr-Jul

78 kaf <small>Official Forecast</small>	217.2% <small>of Historical Median</small>	105.4% <small>of Historical Mean</small>
63 kaf <small>90% Exceedence</small>	95 kaf <small>10% Exceedence</small>	17th of 80 <small>Official Historical Flows</small>

[View Water Supply Forecast Plot](#)

[Need Help?](#)

Location Overview

Mesquite
Data CC-BY-SA by [OpenStreetMap](#)

[Zoom To Location On National Water Resources Map](#)
[Western US Water Supply Map](#)

Nearby Points

[Virgin River near Virgin Hurricane \(HURU1\)](#) 57 miles
[Santa Clara River near Santa Clara Pine Valley \(STCU1\)](#) 67 miles
[Virgin River at Virgin Virgin \(VIRU1\)](#) 75 miles
[Coal Creek near Coal Ck Cedar City \(COAU1\)](#) 117 miles
[Sevier River at Sevier Hch \(HATU1\)](#) 157 miles

Seasonal Ensemble Outlook ?

Forecast Period: Apr-Jul

49 kaf <small>50% Exceedence</small>	137.6% <small>of Historical Median</small>	72% <small>of Historical Mean</small>
38 kaf <small>90% Exceedence</small>	77 kaf <small>10% Exceedence</small>	

Forecast Issued: Mar 24 2010

[View Seasonal Ensemble Outlook Plot](#)

Monthly Ensemble Outlook

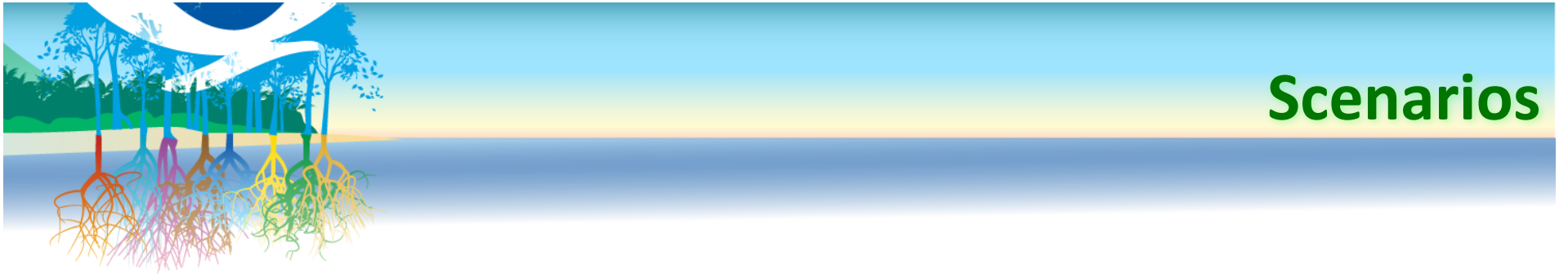
Month: May 2010

90% Chance of Exceedence	50% Chance of Exceedence		10% Chance of Exceedence
23.1 kaf	28.4 kaf	252.1% <small>of historical median</small>	94.2% <small>of historical mean</small>
			32.8 kaf

Forecast Issued: Apr 30 2010

[View Ensemble Prediction Plot](#)

29



Scenarios

What actions would you take to ensure a high enough level in the reservoir for the July 4th holiday?

Type of forecast	increase reservoir releases	decrease reservoir releases	maintain releases
Average	0	71%	29%
Below average	0	100%	0
Above average	16%	34%	50%



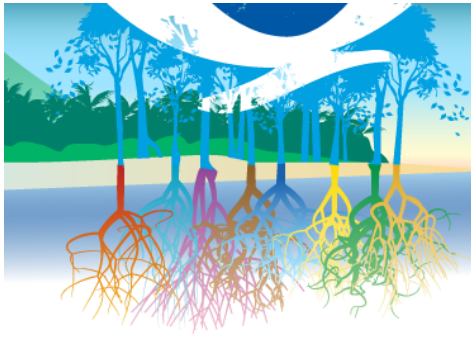
Next Iteration...

- **Climate Literacy and Background Survey**
 - **Evolved Usability Survey**
- **Scenario #1: Gaming Activity! Short-term Forecasts**
- **Scenario #2: Reservoir Management: Monthly Forecast**
 - **Scenario #3: Boat Ramp: Seasonal Forecast**
 - **Scenario #4: Long-term Climate Forecast**

Utah... here we come!

August 2 workshop: postponed

New Utah-based WWA hire: first project



Next Iteration...

- **Climate Literacy and Background Survey**
- **Evolved Usability Survey**
- **Scenario #1: Gaming Activity! Short-term Forecasts**
- Scenario #2: Reservoir Management: Monthly Forecast
 - Scenario #3: Boat Ramp: Seasonal Forecast
 - **Scenario #4: Long-term Climate Forecast**

*Climate literacy is tough when you can't use the word climate
Some web content has changed, but questions remain the same*

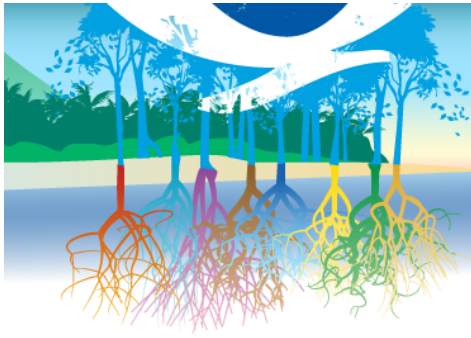
Tests whether changes are improvements

Intermountain West Climate Summary

Written summary of the tool and

Leveraging the teaching aspect of the survey

http://www.surveymonkey.com/s/NWRO_Feedback



Next Iteration...

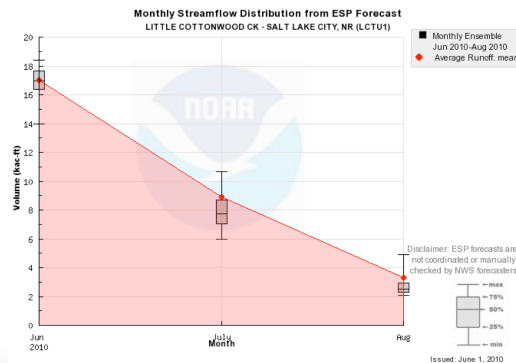
- Climate Literacy and Background Survey
- Evolved Usability Survey
- **Scenario #1: Gaming Activity! Short-term Forecasts**
- Scenario #2: Reservoir Management: Monthly Forecast
 - Scenario #3: Boat Ramp: Seasonal Forecast
 - Scenario #4: Long-term Climate Forecast

- *Testing response to changing information with a real scenario*
- *Participants presented with possible actions & asked to choose an action based on the information*

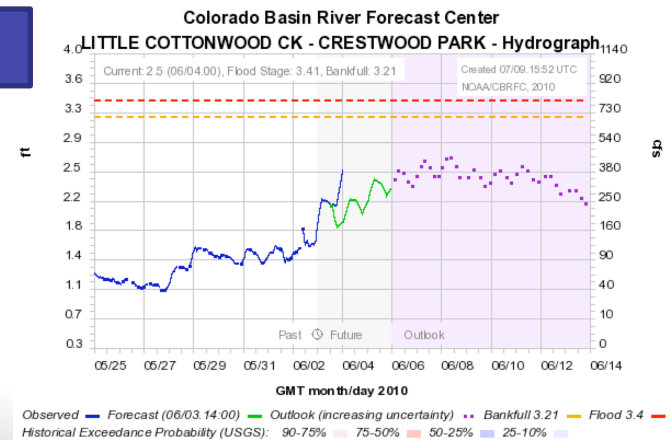
Possible Actions: (Check all that apply)

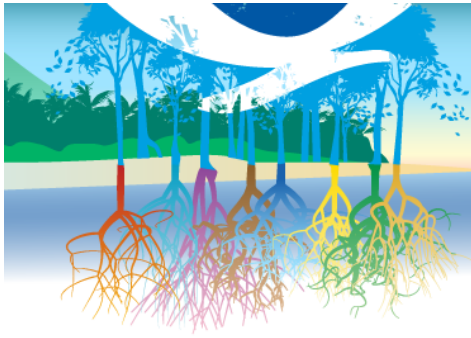
- 1- Post "no diving" signage
- 2- Post "no swimming" signage
- 3- Post warning at campsites near water of possible overnight flooding
- 4- Prohibit overnight camping near water
- 5- Prohibit any activities (picnics, camping, fishing, etc) near the river
- 6- Evacuate campground immediately

June 1



June 2

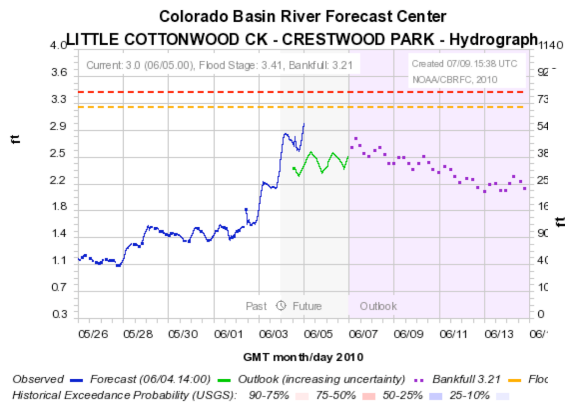




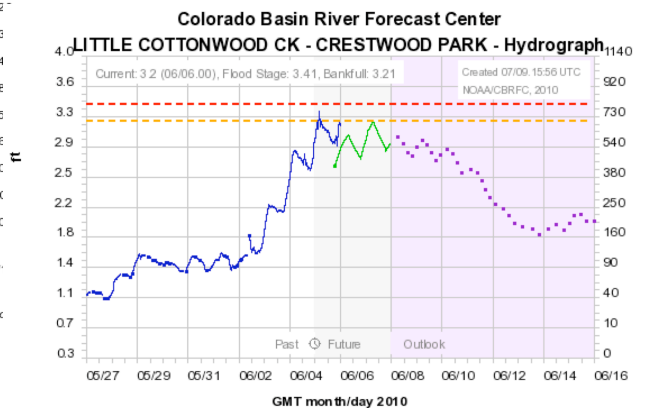
Next Iteration...

- Climate Literacy and Background Survey
- Evolved Usability Survey
- **Scenario #1: Gaming Activity! Short-term Forecasts**
- Scenario #2: Reservoir Management: Monthly Forecast
 - Scenario #3: Boat Ramp: Seasonal Forecast
- Scenario #4: Long-term Climate Forecast

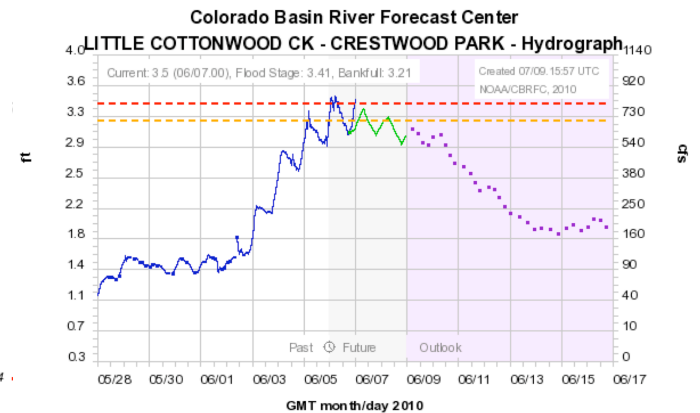
June 3

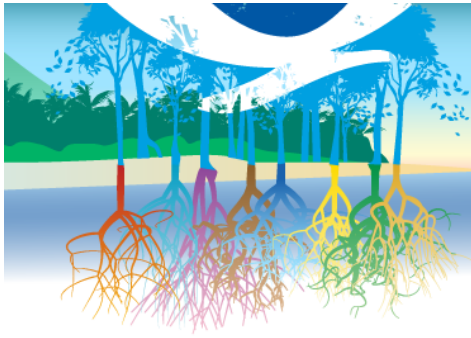


June 4



June 5





Next Iteration...

- Climate Literacy and Background Survey
- Evolved Usability Survey
- Scenario #1: Gaming Activity! Short-term Forecasts
- Scenario #2: Reservoir Management: Monthly Forecast
- Scenario #3: Boat Ramp: Seasonal Forecast
- Scenario #4: Long-term Climate Forecast

- *Collaboration with Riverside*
- *Same scenario but different information*
- *Initial test to evaluate whether we can apply the entire user engagement model to this product*

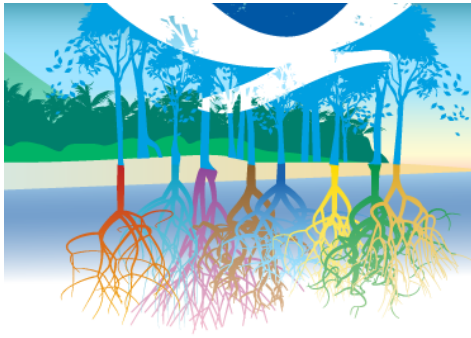
The screenshot shows the homepage of the "Climate Change Decision Support System". The header includes navigation links for "home", "using the system", and "system science", along with a "login" link. The main content area is titled "Concerned about Future Water Availability?" and provides an overview of the system's purpose and a list of key features:

- Understand the impacts of climate change on water resources.
- Access multiple emission scenarios and Global Circulation Models (GCM) being used by today's science community.
- Analyze results from running various combinations of emission and GCM scenarios.
- Use a cost-effective tool to generate, visualize and assess climate affected streamflow.
- Visualize predicted hydrologic impacts using the National Weather Service's River Forecasting System.

Below this, a section titled "A Variety of Users" lists several user groups with brief descriptions and icons:

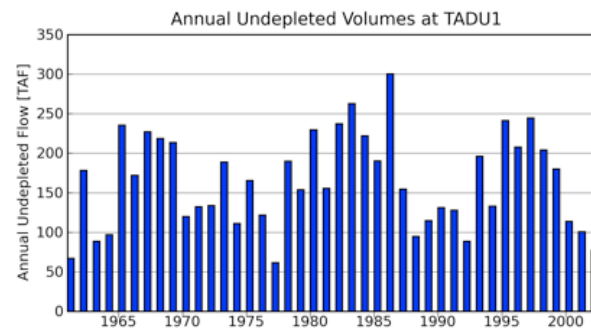
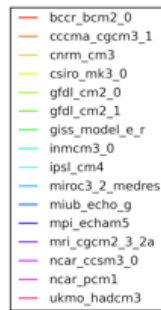
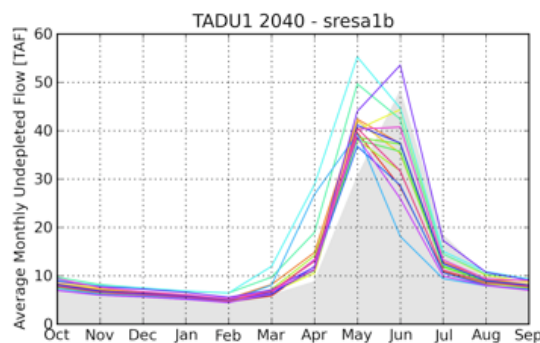
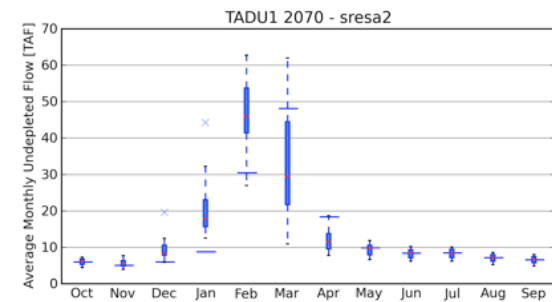
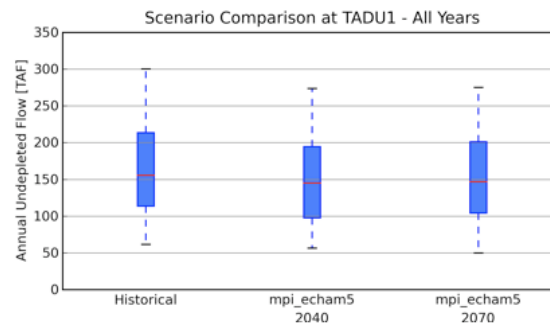
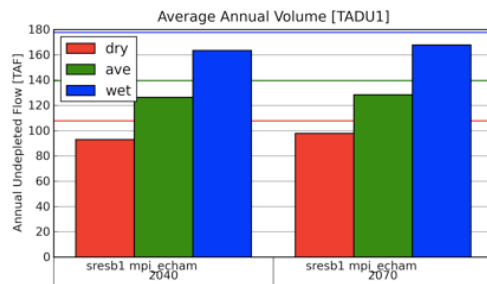
- Water Managers and Planners:** Use as a planning and management tool to assess climate change impacts.
- Agriculture and Irrigation:** Become better informed about future water supply and help decision making ability around land use and agricultural production.
- Municipalities:** Water supply forecasts can be used to evaluate supply deficiencies or surplus enabling informed decisions about water use, conservation and potential operational risk.
- Land Use and Urban Planning:** Evaluate data outputs and forecast information to make smart choices about land use and urban planning – ensuring there is enough water to support future development.
- Hydropower:** Understanding current and future water demands to facilitate hydropower and reservoir operations and efficiency.
- Habitat Preservation:** Competing uses require future water availability information to proactively negotiate use agreements.

On the right side of the page, there is a login form with fields for "Username" and "Password", a "Remember me next time" checkbox, and a "Login" button. Below the login form is a "System Shortcuts" section with two buttons: "Basic Viewer" and "Full Viewer", each with a brief description of their functions.



Next Iteration...

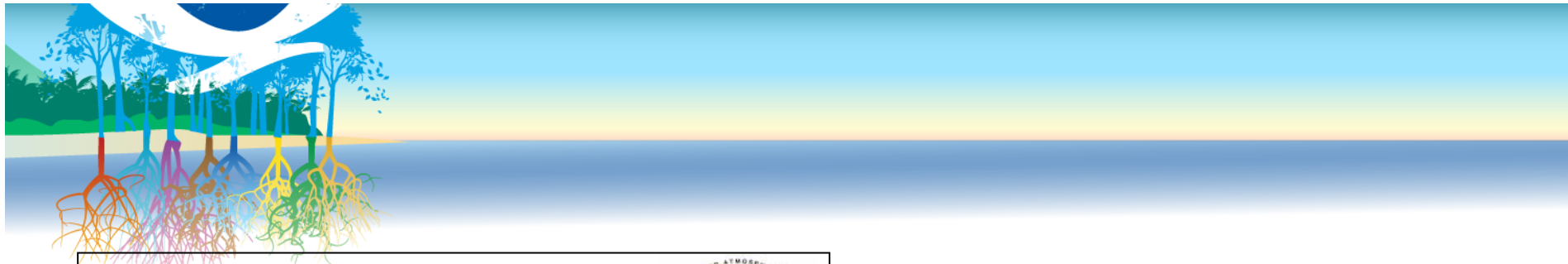
- Climate Literacy and Background Survey
- Evolved Usability Survey
- Scenario #1: Gaming Activity! Short-term Forecasts
- Scenario #2: Reservoir Management: Monthly Forecast
- Scenario #3: Boat Ramp: Seasonal Forecast
- Scenario #4: Long-term Climate Forecast



26 different figures!

Process of creating workshops is continually evolving

Learning process – we learn from our participants just as much as we hope they learn from us about using climate information



Kevin Werner



CBRFC Service Coordination Hydrologist

Phone: 801.524.5130

Email: kevin.werner@noaa.gov



Gigi Owen



Staff Social Scientist, Univ. of Arizona

Phone: 520.621.9001

Email: gigi@email.arizona.edu

WESTERN WATER
ASSESSMENT



Kristen Averyt

Deputy Director, Western Water Assessment

Email: kristen.averyt@noaa.gov

