

NOAA's Colorado Basin River Forecast Center

CBRFC Forecast Precipitation Needs

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Colorado Basin River Forecast Center

May 27, 2015

Workshop - Improving Sub-Seasonal and Seasonal Precipitation Forecasting for Drought Preparedness



Colorado River Basin

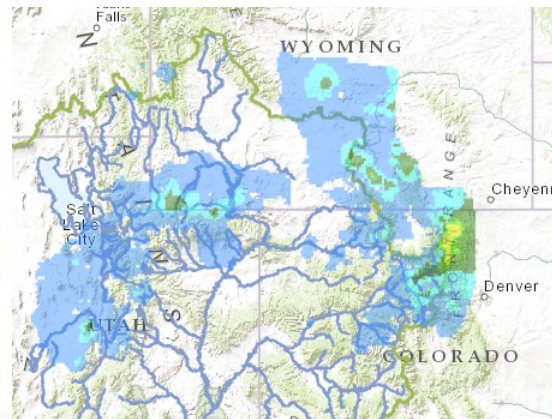
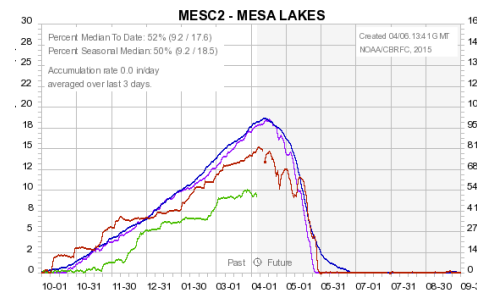
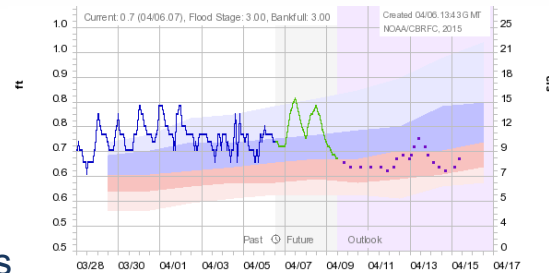
- 40 million people rely on Colorado River water
- 3.5 million acres of irrigation within the basin, another 2.5 outside the basin
- 85% of runoff comes from above 9000 feet
- Large reservoirs hold 4 times the annual runoff
- Decade long drought – Demand now surpasses supply
- Increasing importance of water supply forecasts



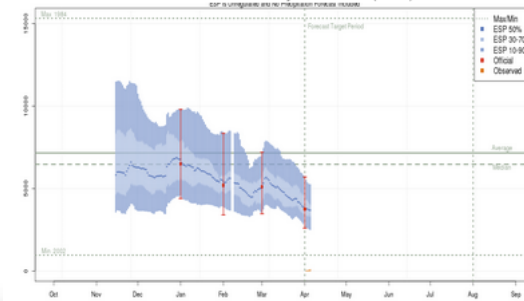
Services

Service.....

- Hydrologic Forecasts
- Meteorological Forcings
 - Precip/temperature/freezing level
- Ensembles & Probabilistic Info
- Water Supply Volumetric forecasts
- Dambreak support
- Specialized Decision Support
- Reservoir conditions and forecast inflow



GLD: Colorado - Lake Powell - Glen Cyn Dam - At (71%)



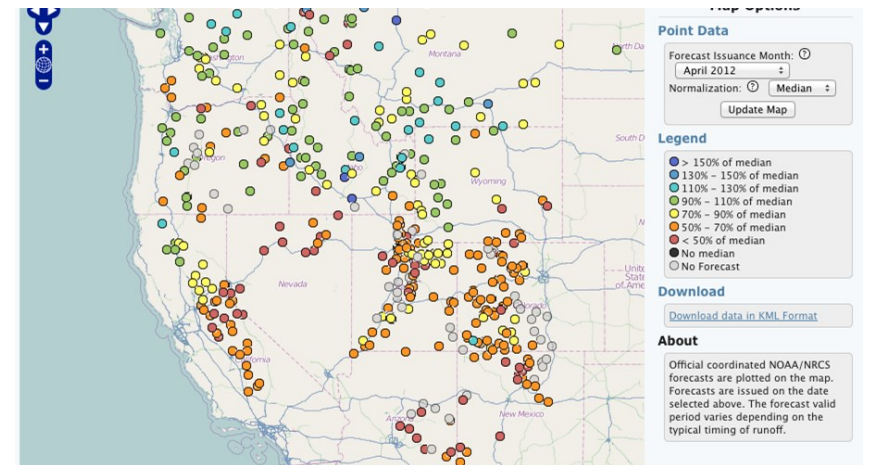
Support.....

- Flood Warning
- Emergency Management
- Water Resource Management
- Drought
- Irrigation
- Recreation
- Hydropower Generation
- Fish and Wildlife Conservation



Water Supply Forecasting

- Probabilistic volumetric forecast of quantity of water to pass a point over a given time period (April-July)
- CBRFC originally created for water supply forecasting only



USBR's role

- USBR manages the reservoirs for the 7 States
- “24 Month Study”: reservoir model used to project releases for Colorado Basin major reservoirs and to develop AOP
- USBR follows rules set in 2007 Interim Guidelines
 - August projections set operations for Lakes Mead and Powell for upcoming year



CBRFC's role

- USBR uses CBRFC's forecast as a major input to their reservoir model
- CBRFC provides twice monthly updates all year round – monthly, seasonal and yearly forecasts and special analysis
- Increased scrutiny
- CBRFC remains neutral in the forecasting process



\$\$ Value of Water Supply Forecasts

- Damage from 1/10 AZ storm: \$11m^a
- Damage from 6/10 UT flooding: \$6.5m^a
- Damage from 12/10 UT/NV storm: \$11m^a
- Damage from 2011 runoff CO/UT: \$5.0m^a

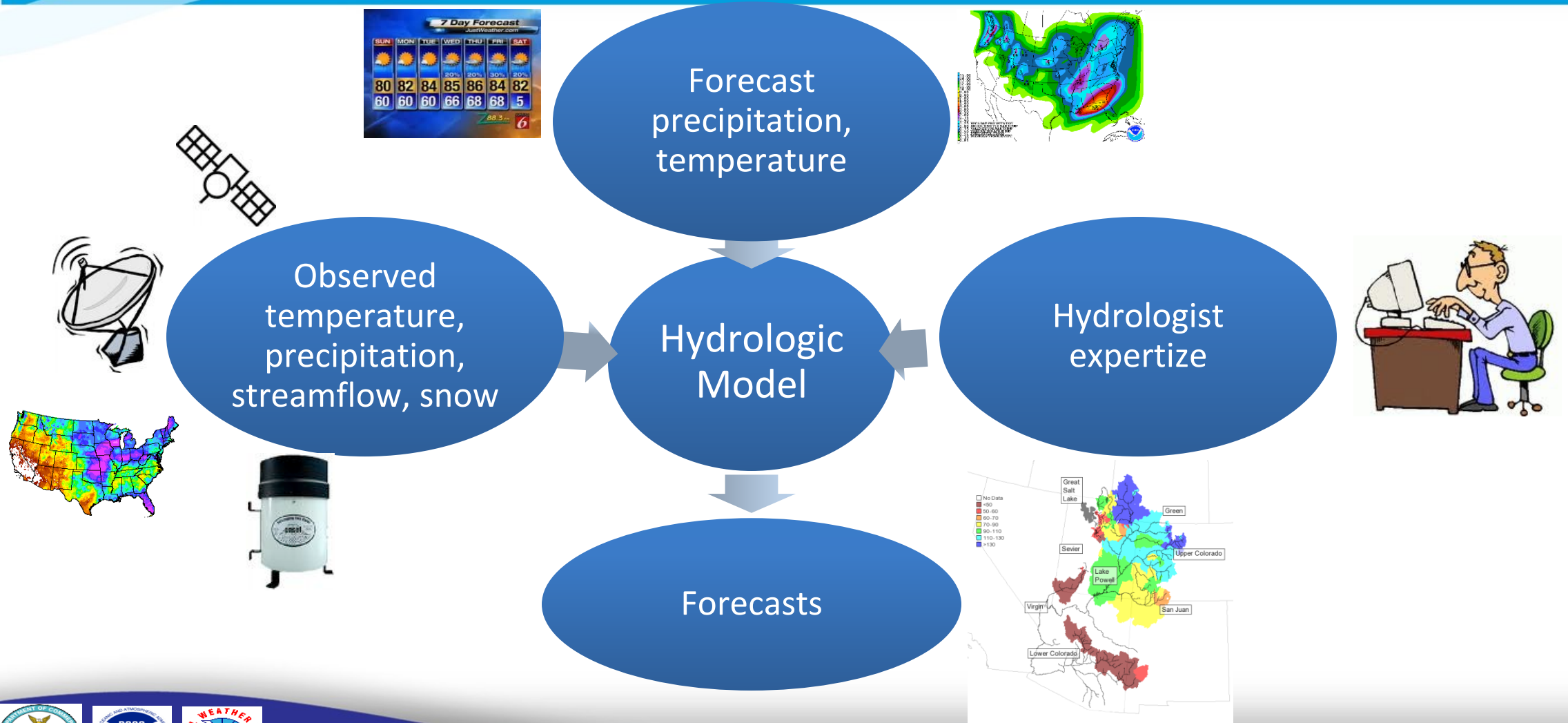
- Colorado River average annual runoff: 15 MAF
- Replacement value of \$200-800/AF -> \$3-12b^b

- **Economic value of water resources (every year) far greater than flooding damages

- Sources:
- a: WFO, FEMA (via stormdata); b: Communication with water managers in basin

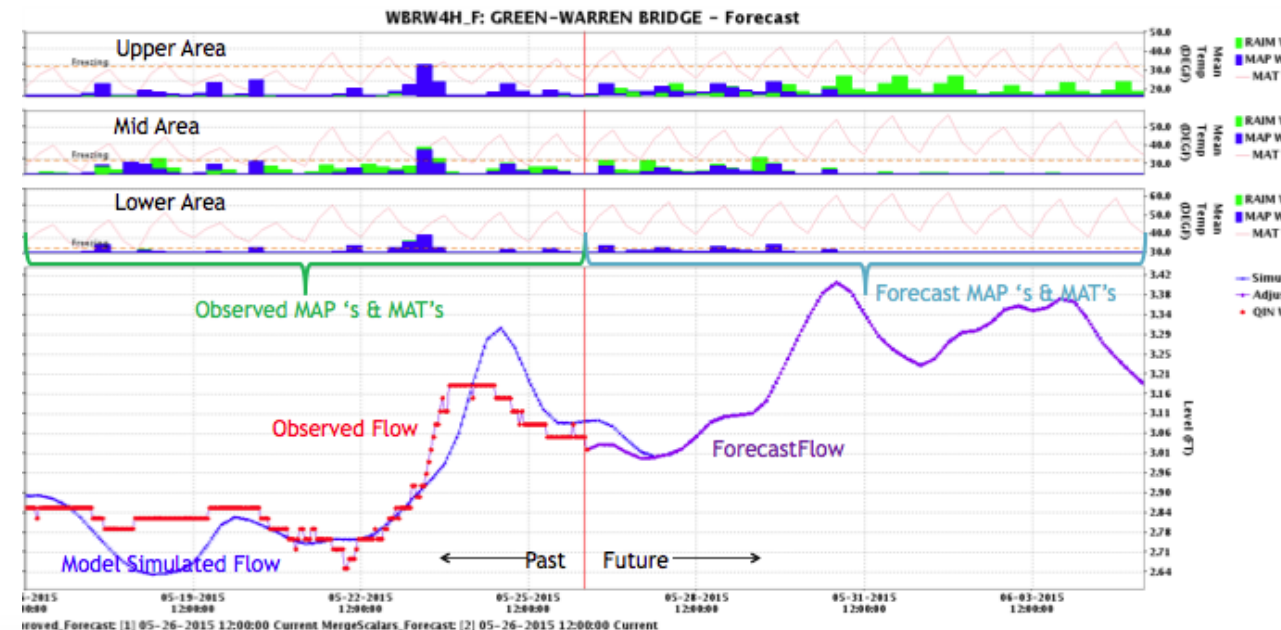


Forecast Process



Daily Deterministic Forecasts

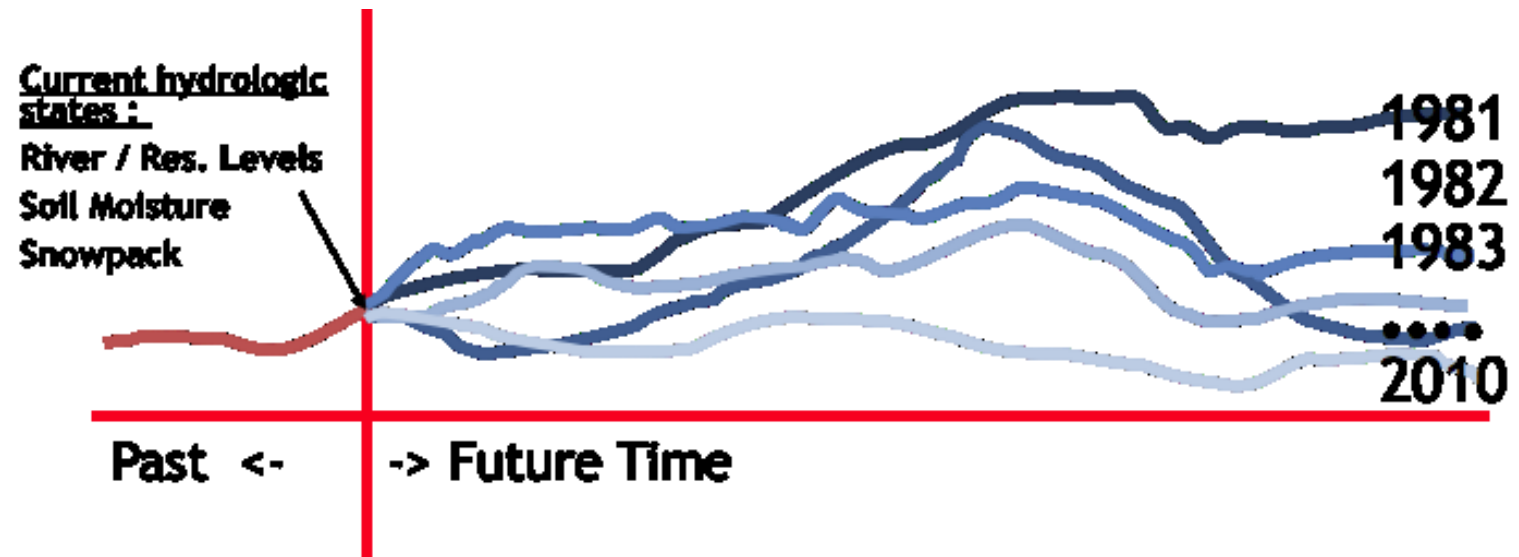
- Start run 10 days back so can see how model simulation compares to observed flows
 - Make sure inputs and forcings are correct
- End 10 days into the future
 - Upper Colorado (above Powell) and Great Basin run on a 6 hour timestep
 - Lower Colorado (below Powell) and Sevier Basin run on a 1 hour timestep
- Regulated (trying to match observed flow in river)
 - Future diversions:
 - Set to current
 - Specified
 - Best guess
 - Future reservoir releases:
 - Set to current
 - Specified
 - Spill
- 5 day deterministic precipitation forecast
 - 6 hour timestep
 - (evenly divided for 1 hour segments)
 - Zero beyond 5 days
- 10 day deterministic temperature forecast
 - Max/Min forecasts converted to 6 hour timestep



Ensemble Streamflow Prediction

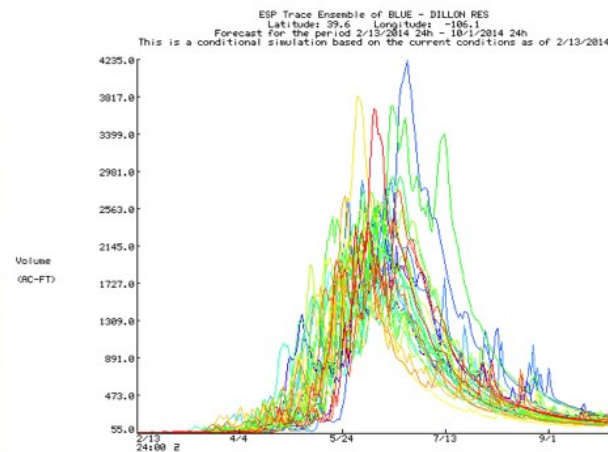
Probabilistic Forecasts

- Start with current conditions
- Apply precipitation and temperature from each historical year (1981-2010) *going forward*
- A forecast is generated for each of the years (1981-2010) *as if, going forward*, that year will happen
- This creates 30 possible future streamflow patterns. Each year is given a 1/30 chance of occurring



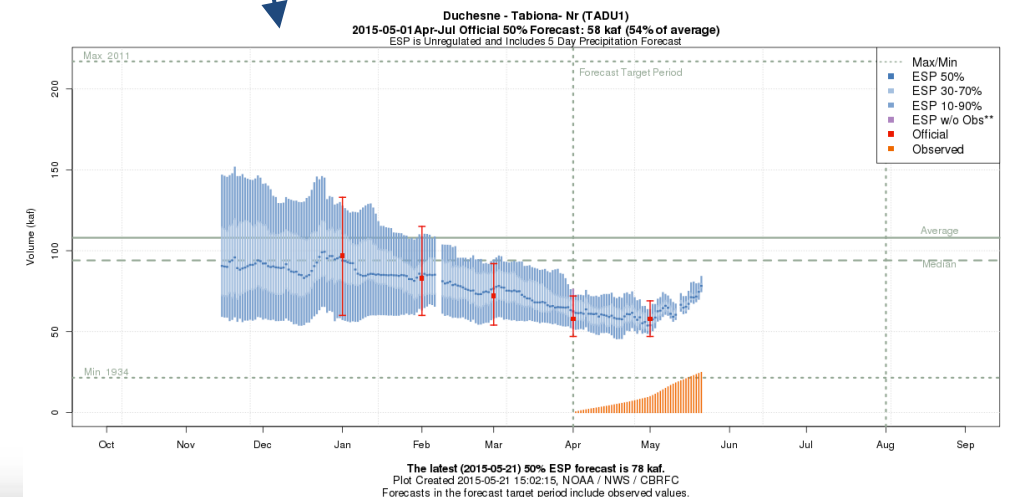
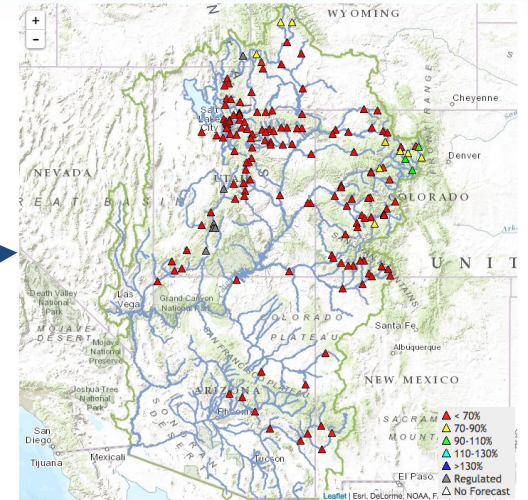
ESP Probabilistic Forecasts

1. Flows summed into volumes
2. Generate Statistics
3. Create Products



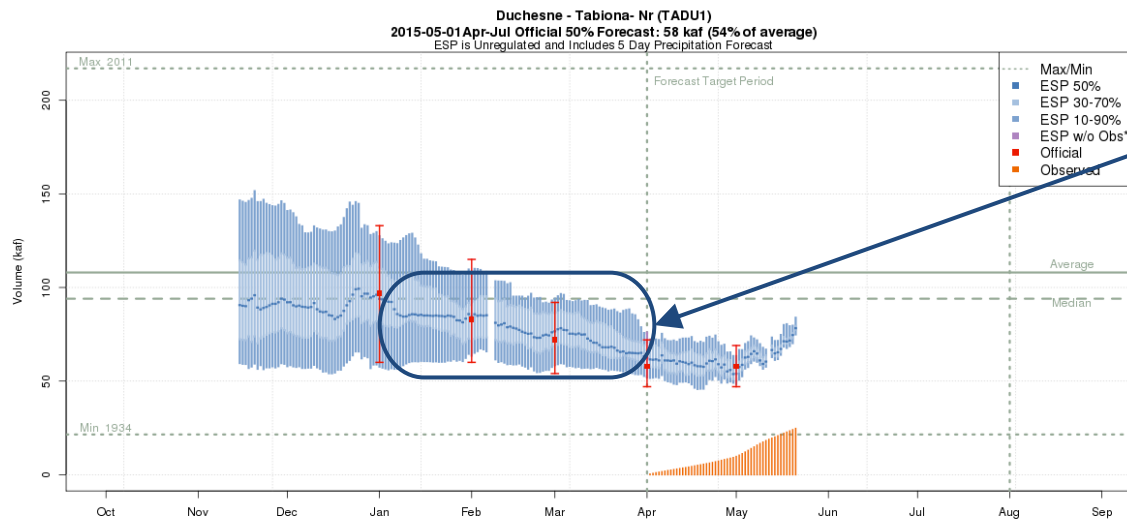
#Trace	Year	Cond.	Data Exceed.
#	Weight	Point	Prob.
1981	0.033	177211.438	0.641
1982	0.033	176045.719	0.671
1983	0.033	264999.438	0.061
1984	0.033	221810.359	0.254
1985	0.033	203260.516	0.411
1986	0.033	208865.734	0.355
1987	0.033	160108.203	0.835
1988	0.033	170150.953	0.741
1989	0.033	202772.094	0.451
1990	0.033	189682.000	0.581
1991	0.033	202233.734	0.484
1992	0.033	169767.188	0.774
1993	0.033	260266.516	0.091
1994	0.033	173539.250	0.710
1995	0.033	332482.281	0.032
1996	0.033	237575.438	0.161
1997	0.033	201420.719	0.514
1998	0.033	160373.312	0.804
1999	0.033	237255.172	0.194
2000	0.033	217391.062	0.290
2001	0.033	204273.781	0.381
2002	0.033	109645.195	0.964
2003	0.033	240024.969	0.121
2004	0.033	151270.719	0.901
2005	0.033	156270.141	0.871
2006	0.033	145418.188	0.931
2007	0.033	181728.625	0.611
2008	0.033	212733.891	0.321
2009	0.033	222155.312	0.224
2010	0.033	192733.172	0.544

# Exceedance	Conditional
# Probabilities	Simulation
0.900	151770.656
0.800	162252.078
0.700	174291.188
0.600	184909.969
0.500	201827.219
0.400	207868.469
0.300	215993.891
0.200	234235.078
0.100	258242.141



ESP Precipitation Forecast

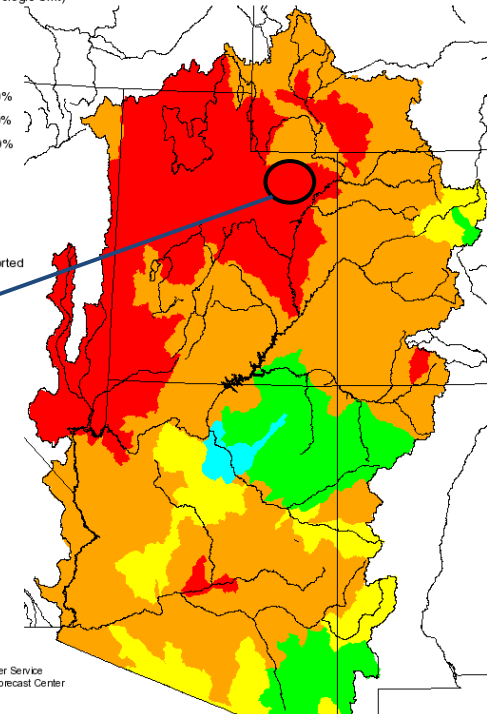
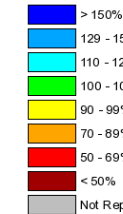
- Only 5 days of Forecast Precipitation in simulation
- Climatology rest of period
- Model always trends to median
- In example here, as it continued to stay dry the model guidance trends downward



The latest (2015-05-21) 50% ESP forecast is 78 kaf.
Plot Created 2015-05-21 15:02:15, NOAA / NWS / CBRFC
Forecasts in the forecast target period include observed values.

Seasonal Precipitation, October 2014 - April 2015
(Averaged by Hydrologic Unit)

% Average

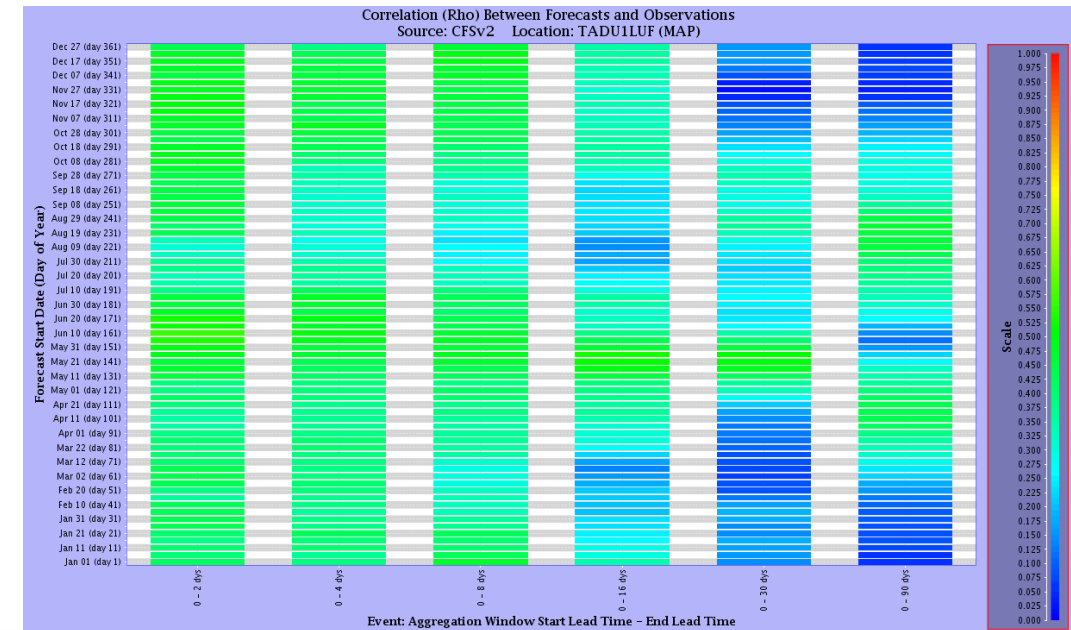
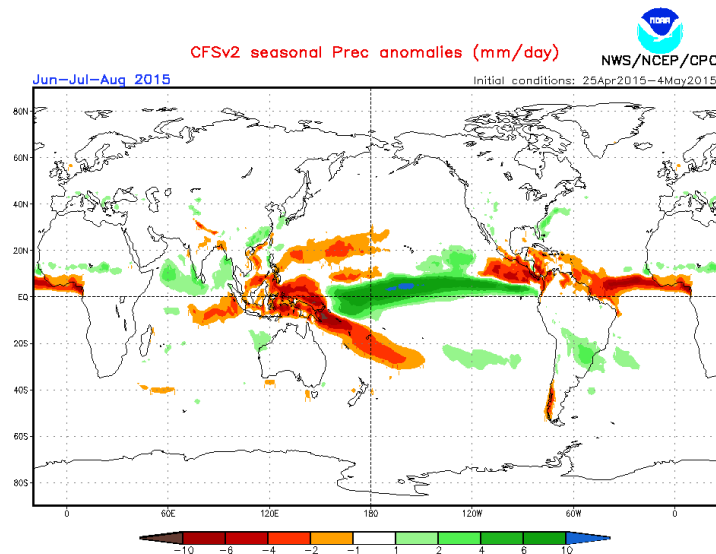


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www.cbrfc.noaa.gov



CFSv2 forecast skill

- New system Hydrologic Ensemble Forecast Service (HEFS) can include the Climate Forecast System (CFSv2) forecast.
- Though skill in forecast is limited in the CBRFC's area.



Summary

- Water Supply Forecasting program very important – done with very little resources
- Value of forecasts is only going to increase - important to continuously improve services
- Skillful Precipitation Forecast out to at least 90 days would help improve guidance for water supply and reservoir operations.



Study: Drought will cut flow from Lake Powell

Dennis Wagner, USA TODAY 4:03 p.m. EDT August 17, 2013

Dwindling Colorado River Forces First-Ever Cuts in Lake Powell Water Releases

Terrell Johnson | Published: Aug 20, 2013, 9:07 AM EDT | weather.com



© 2013 The Salt Lake Tribune. All rights reserved. The photo shows Lake Powell, which is the largest man-made lake in the United States. The photo was taken from the Glen Canyon Dam, which is the largest concrete dam in the world. The photo was taken on August 17, 2013.

Feds announce cuts to releases from Lake Powell

Colorado River » Move will reduce outflow to lowest since Lake Powell's creation, add pressure on Lake Mead.



Colorado Basin River Forecast Center

Thank You

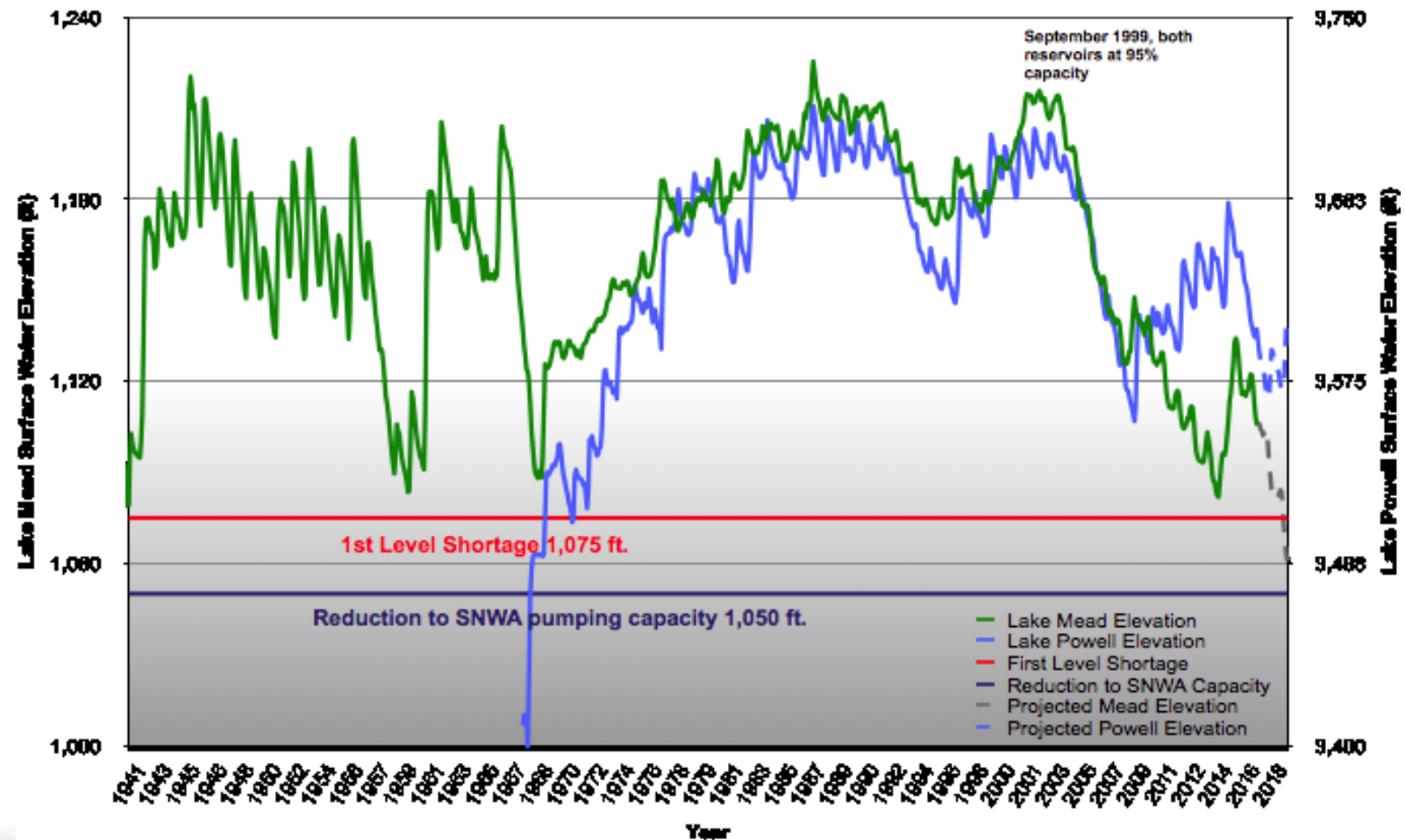


extras below



End of Month Elevation at Lakes Powell and Mead

Projected data based on Reclamation's August 2013 24-Month Study

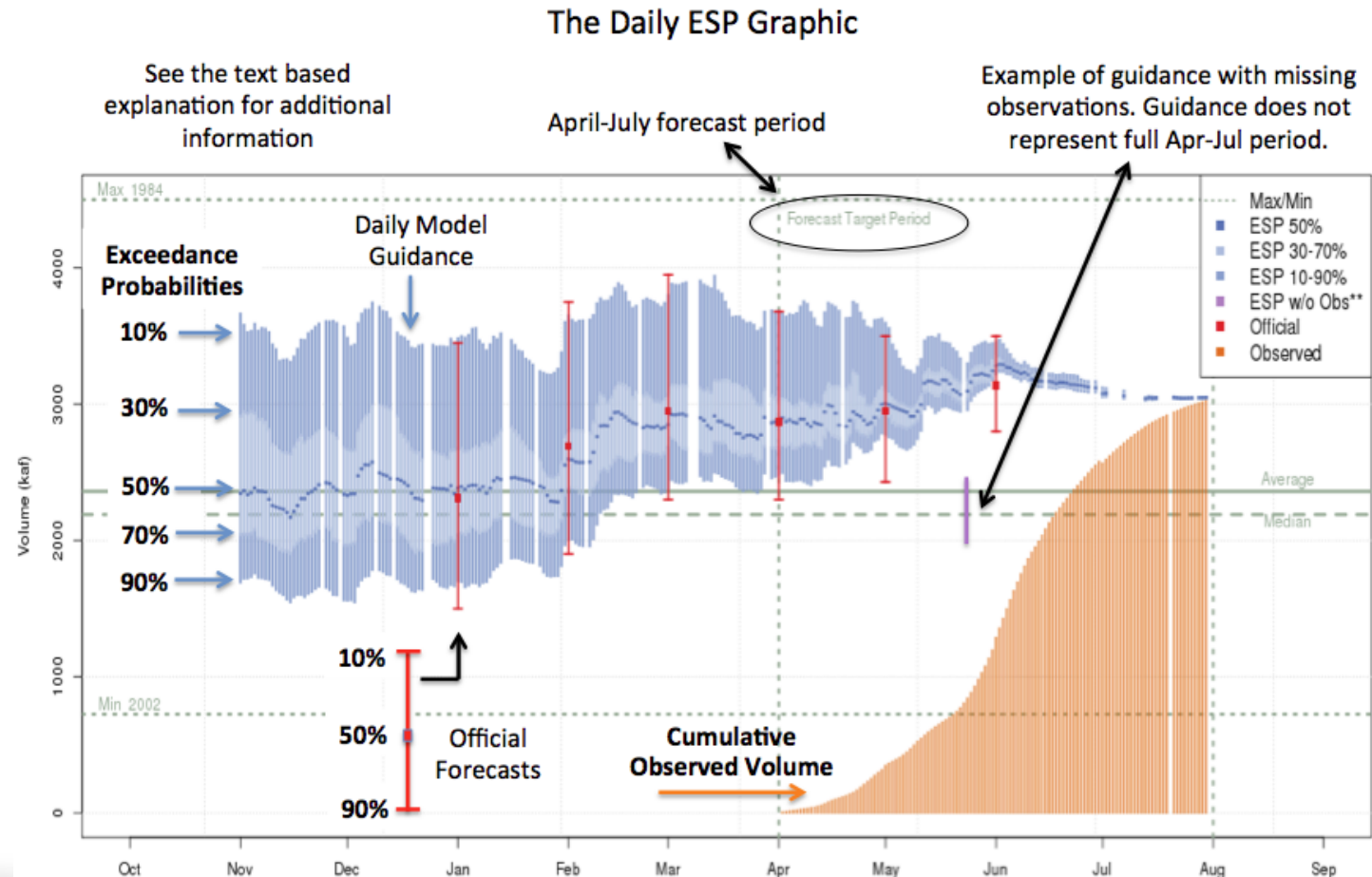


Water Supply = Local Decision Support

- Provide special forecasts and information to Reclamation, and other water management agencies
- Participate Basin States Technical Committee meetings, Public and Reservoir meetings to support Reclamation (10 to 15 a year)
- Respond to inquiries and requests all year round – changes with hydrologic conditions
- Proactively ensure Reclamation is getting what they need from us
- Engaged in USBR model improvement projects

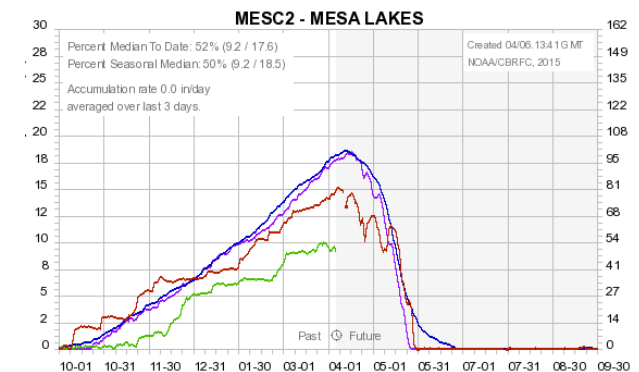
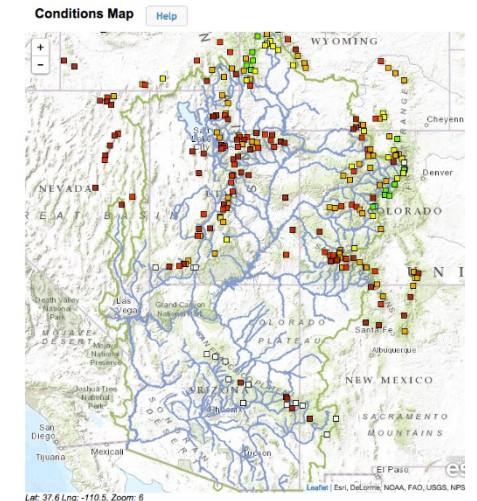
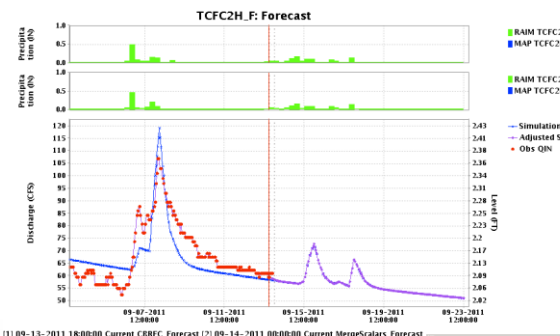


Explanation of Daily ESP Graphic



Activities

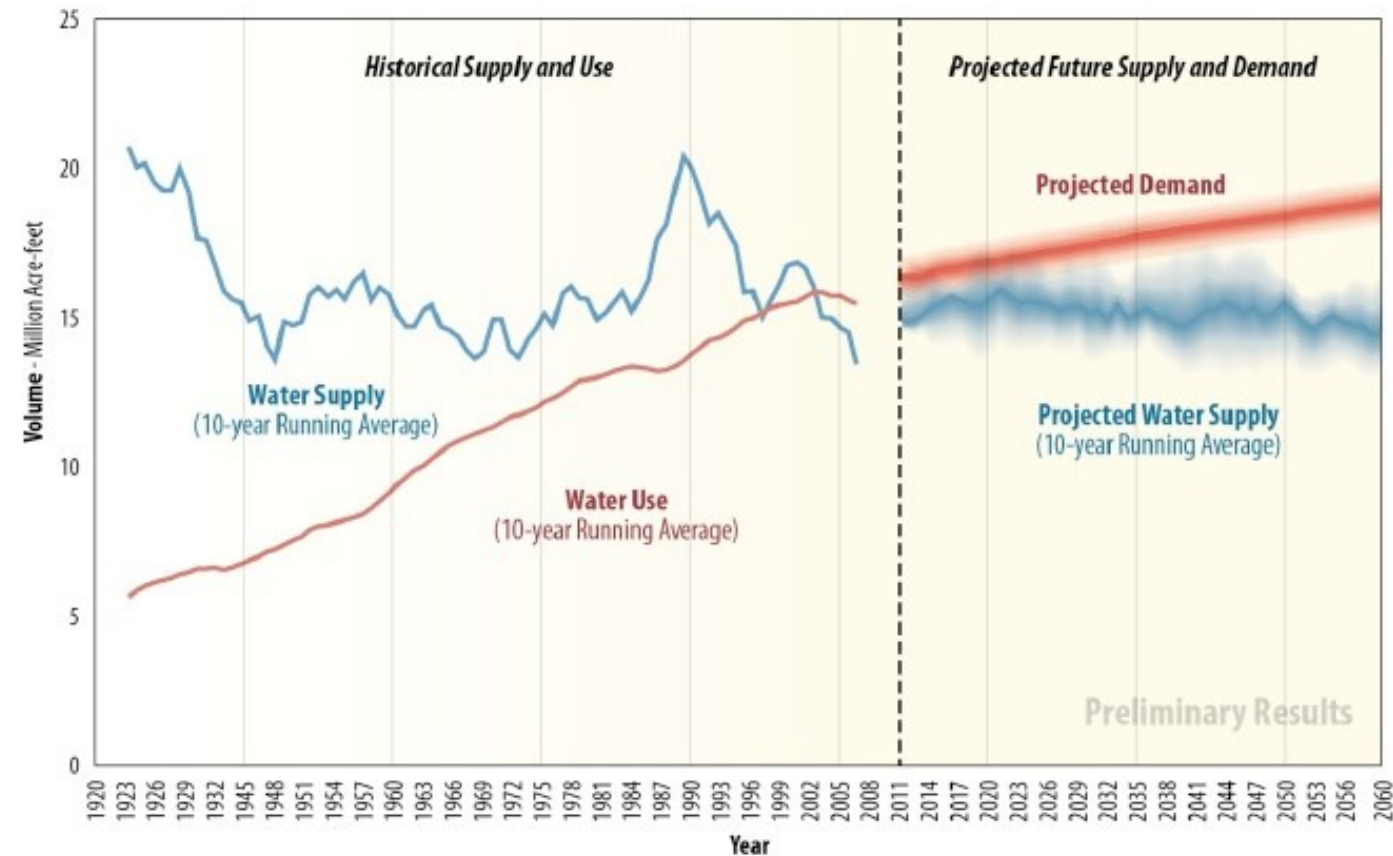
- Continuous data assimilation, modeling, and preparation of hydrologic information and forecasts
- Technical support and collaboration with WFOs, Regional/National HQ, and other Federal water agencies.
- Technical support and interaction with outside water management groups and stakeholders.
- Specialized Impact Decision Support Services
- Operational procedure development.



Long Term Supply / Demand Colorado River

FIGURE 2

Historical Supply and Use and Projected Future Colorado River Basin Water Supply and Demand



Courtesy USBR