

# RECLAMATION

*Managing Water in the West*

## **Progress and Prospects for Connecting the Water Resource Communities: Predictions, Applications, and Decision**

James Prairie, Bureau of Reclamation

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Denver, CO



U.S. Department of the Interior  
Bureau of Reclamation

# Understanding Climate Change Variability

- Mix of research, capacity building, and scoping
  - Long-term Climate Change Impacts
  - Short-term Climate Variability, from Floods to Droughts
  - Developing Data, Tools, and Training Resources

## Short-term Water Operations

Interconnected Decisions that (1) address different objectives, (2) occur at different time-resolutions, (3) are updated on different cycles.

*These decisions are informed by a suite of hydrologic predictions*

### Fine Resolution (Duration: hours to days)

• Objectives addressed at this Resolution: emergency response, flood risk management, hydropower, navigation

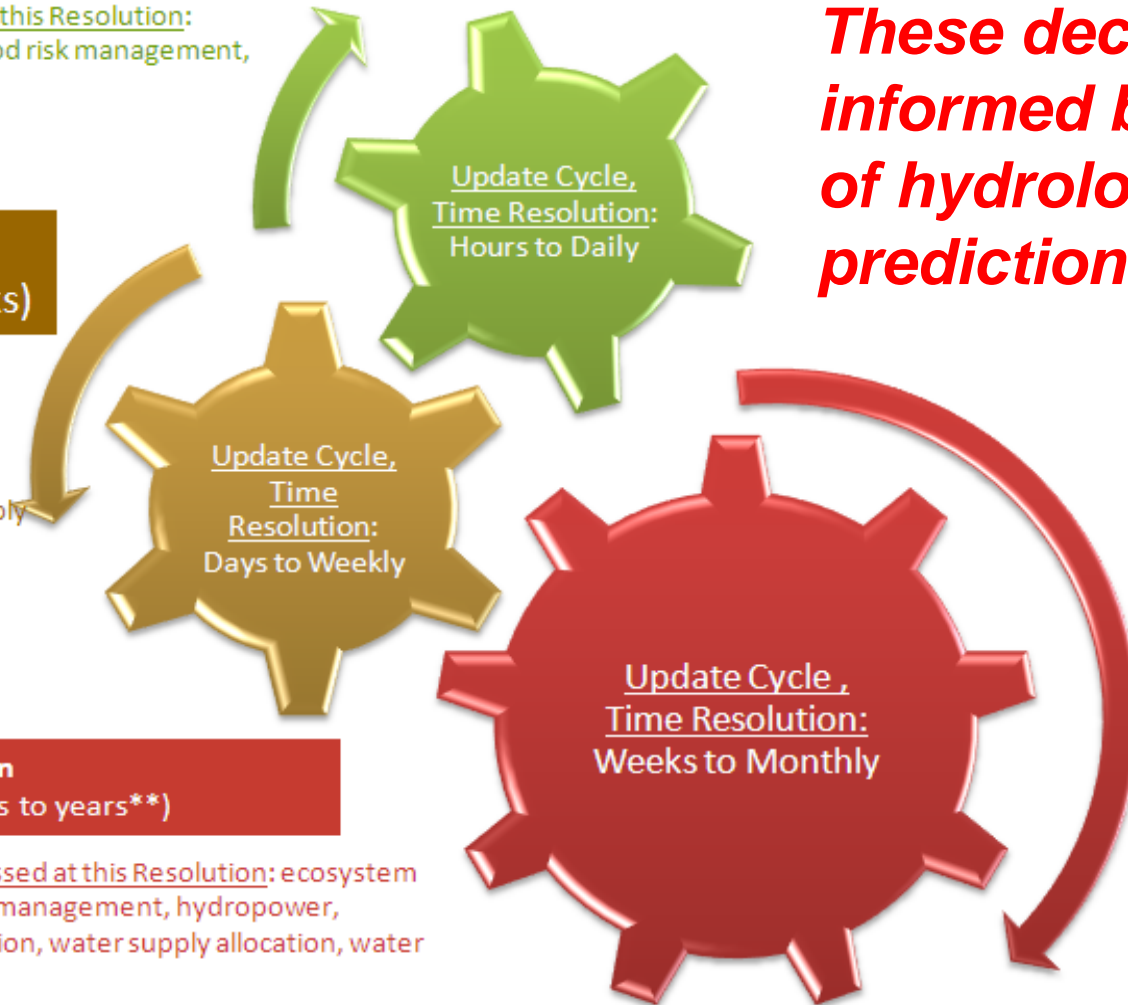
### Medium Resolution (Duration: days to weeks)

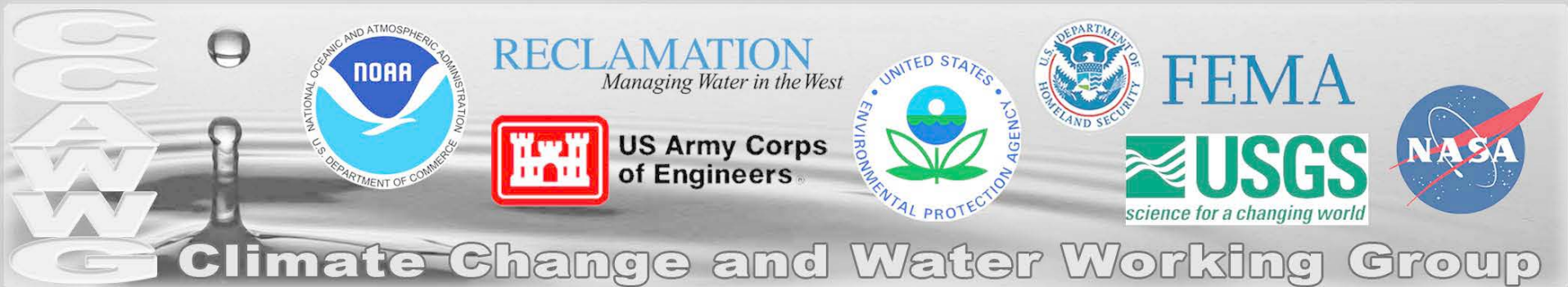
• Objectives addressed at this Resolution: ecosystem support, emergency response, flood risk management, hydropower, navigation, recreation, water supply conservation (e.g., snowmelt management), water delivery

### Coarse Resolution (Duration: seasons to years\*\*)

• Objectives addressed at this Resolution: ecosystem support, flood risk management, hydropower, navigation, recreation, water supply allocation, water delivery

\*\* Most systems prepare outlooks having a duration of one-year or less.





- Drivers
  - Most of our decisions involve contemporary water management
  - We can increase our ability to adapt to climate change by improving contemporary use of monitoring & forecasts
- Report summarizes needs
  - monitoring
  - forecasting
  - information use

[www.ccawwg.us/docs/Short-Term\\_Water\\_Management\\_Decisions\\_Final\\_3\\_Jan\\_2013.pdf](http://www.ccawwg.us/docs/Short-Term_Water_Management_Decisions_Final_3_Jan_2013.pdf)

**Short-Term Water Management Decisions**

User Needs for Improved Climate, Weather, and Hydrologic Information

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# Summary of Needs: Monitoring

Sub-Category	Label	Need Statement
General	M1	Sustained support for monitoring networks that provide observations of weather and hydrologic conditions.
Precipitation	M2	Expanded networks of weather stations in water management regions that are currently served by relatively low station density.
Snowpack	M3	More interactive snow analysis products characterizing basin-distributed snow-covered area and snow-water equivalent
	M4	Expanded networks of snow-observing stations in the Central and Eastern United States.
Streamflow	M5	Preserving and expanding networks of streamflow observations with a focus on streams and rivers that are currently ungauged.

# Example Reclamation R&D investment: Airborne Snow Observatory – Value of Information Project (NASA JPL, Reclamation UC/TSC)

- FY13-14 Project:
  - Assess value of (1) improved hydrology model and (2) enhanced snow & dust monitoring w.r.t. spring reservoir operations
  - Basins: Gunnison & San Juan (Colorado)
- Approach
  - Synthetic ASO →
  - Alternative hydrologic forecasting methods
  - ops under each alternative
  - valuation of ops differences



Fig. NASA

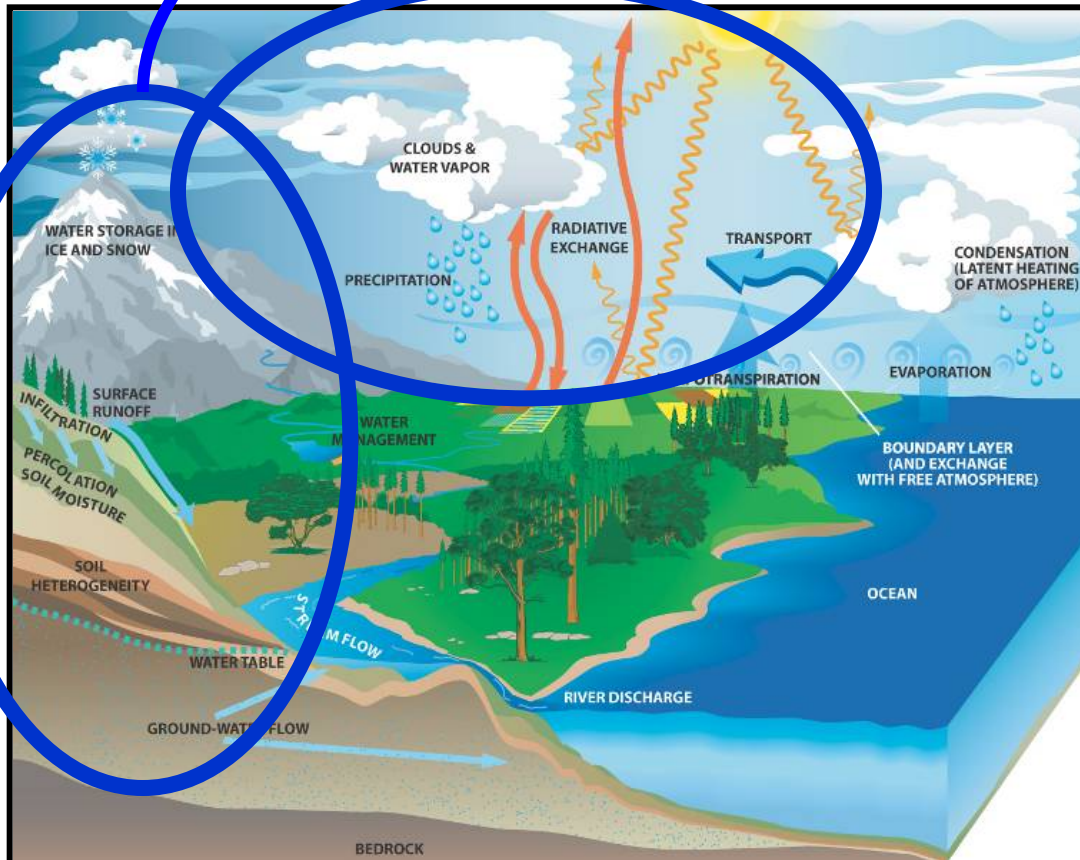
# Summary of Needs: Forecasting

Sub-Category	Label	Need Statement
General	F1	Enhanced suite of hydrologic predictions spanning lead -times of days to seasons and consistent with the continuum of weather to climate forecast products.
Precipitation, supporting Fine Resolution Outlooks	F2	More reliable quantitative precipitation forecasts (QPF) on lead times of hours to days.
	F3	Improved precipitation forecasts for landfalling storms in coastal areas.
Streamflow, supporting Fine Resolution Outlooks	F4	Enhanced streamflow predictions on lead times of hours to days, particularly during storm events.
Streamflow, supporting Med. Resolution Outlooks	F5	Enhanced streamflow predictions on lead times of days to weeks, particularly during the snowmelt season
Runoff Volume, supporting Coarse Resolution Outlooks	F6	Improved anticipation of runoff volumes during lead times of months to seasons.
Water Level	F7	Enhanced prediction products characterizing potential water levels during storm events.
Other Hydroclimate	F8	Multi-variate suite of climate to hydrologic predictions that comprehensively characterizes the state and evolution of basin hydrologic conditions on lead times of days to seasons.

# *Opportunities for prediction*

*hydrological predictability*

*meteorological predictability*



Water Cycle (from NASA)

Hydrological Prediction: How well can we estimate the amount of water stored?

Accuracy in precipitation estimates

Fidelity of hydro model simulations

Effectiveness of hydrologic data assimilation methods

Meteorological predictability: How well can we forecast the weather?

Opportunities: Which area has most potential for different applications?



# Example Reclamation R&D Investment: Streamflow Predictability Project (NCAR RAL, USACE, Reclamation R&D/TSC, FY 13-15)

- Assess performance of current hydrologic models used by the NWS, and assess dependence of model performance on
  - Physical characteristics of the basins (climate, vegetation, soils, topography)
  - Reliability of quantitative precipitation estimates (e.g., station density, radar)
- Assess the relative importance of hydrologic and meteorological/ climatological information in determining forecast skill
- Conduct research to improve estimates of uncertainty
  - During model spin-up
  - During the forecast period
- Conduct research to reduce forecast uncertainty
  - Better hydrologic models
  - Better weather forecasts and climate outlooks
  - Adoption of hydrologic data assimilation methods and statistical post-processing methods
- Examine impact of different sources of uncertainty in water management decisions

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# Summary of Needs: Information Use

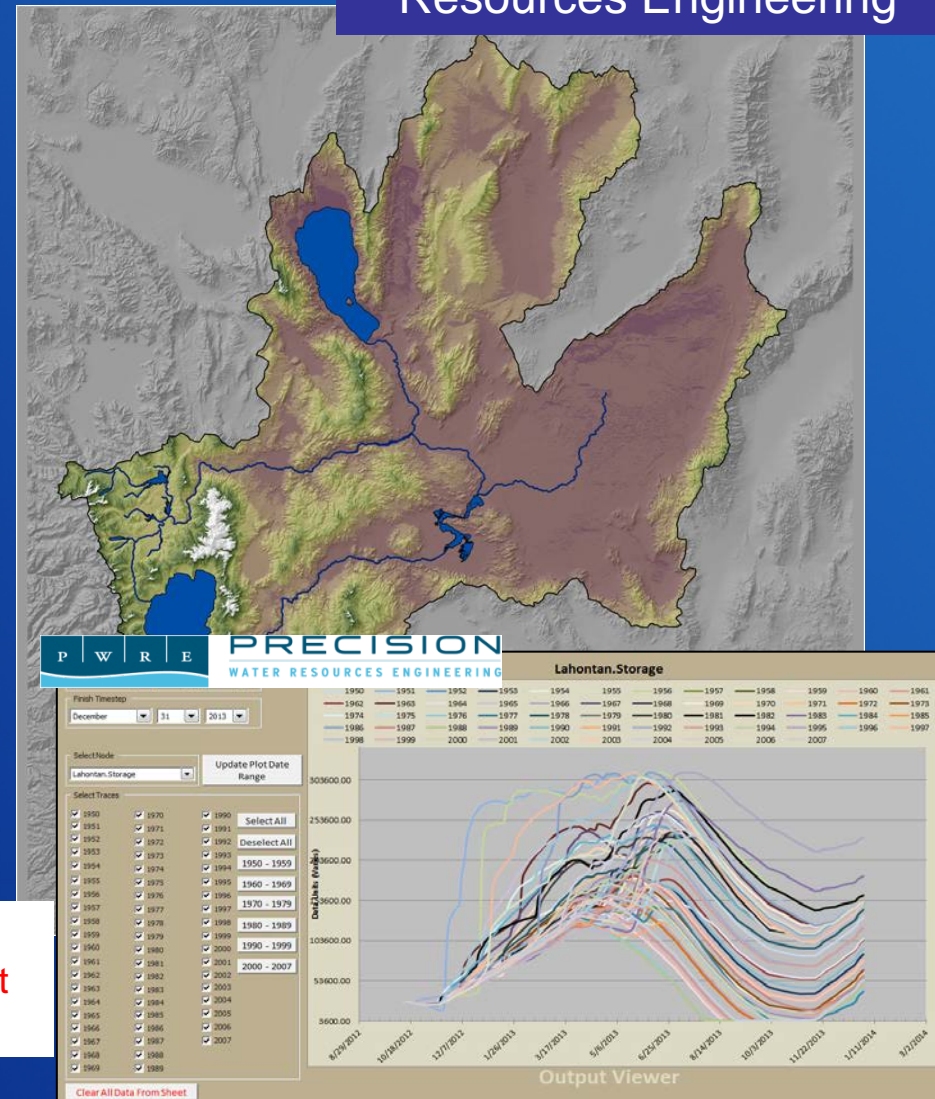
Sub-Category	Label	Need Statement
Information on Product Development and Qualitative Attributes	U1	More detailed meta-information describing product skill, reliability, and development.
Information Synthesis	U2	Guidance on how to synthesize available hydroclimate information relative to its collective applicability to water management situations.
Education on Water Management and Forecasting Principles	U3	Training resources on water management principles spanning multiple time-scales.
	U4	Training resources on probabilistic forecasting principles and risk-based decision-making.

# Example Reclamation Regions Applications: Developing “Ensemble Operations Outlooks” (Riverware community; UC & MP)

Fig. Precision Water  
Resources Engineering

- Goal: Expand capacity to explore hydrologic scenarios and communicate operational uncertainties
- Develop model that emulates operator sensibility
  - information synthesis
  - consideration of management requirements and constraints
  - discretionary target setting for storage, release, deliveries, etc
- Model is like “Mapquest”, not a blind optimization tool

(e.g., Truckee/Carson Basins, Oct 2012 outlook for WY 2013: 11 of 58 (19%) forecast traces show shortage on Newlands Project)



# NOAA-Reclamation Drought Meeting

## November 6-7, 2012

- Themes
  - focus on drought-affected basins in 2012, review hydrology and operations;
  - consider 2013 hydrologic outlooks and associated operations;
  - discuss science needs
- Sponsors:
  - NIDIS, NOAA Earth System Research Laboratory, and Reclamation R&D
- Participants:
  - NOAA (NWS RFCs, CPC, ESRL), NIDIS, Reclamation (Ops. staff, R&D)
- Presentations:;
  - <http://drought.gov/drought/news/workshop-%E2%80%93-review-2012-drought-and-preparing-water-year-2013-drought-possibilities>

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# User Needs, Science Discussion

- Seasonal Prediction e.g.,
  - better spring season runoff volume forecasts (UC, MP); more tributaries (UC)
  - better alignment of RFC ESP hydrology forecasts w/ CPC products (MP) or CFSv2 (CNRFC, CBRFC)
  - teleconnections for regions w/ weak ENSO signal (UC)
  - more hindcast diagnostic, focus on years with big errors, identify reasons (GP)
- Science Opportunities
  - Focus: Jan-Jun runoff
  - role of basin antecedence → case for monitoring, data assimilation?
  - role of better climate forecasts → use CFSv2, NMME? focus on influential variables & months?
- Sub-seasonal Prediction during Spring
  - better snowmelt information during the snowmelt season (GP, UC, PN)
  - better ability to predict May-June precipitation (PN, GP); April lead is sufficient
- Science Opportunities
  - One-month outlooks w/ one-month leads (during spring) receives less attention than 3-month outlooks w/ longer leads ... Harder problem? Off the radar?
- Hydrologic monitoring needs were also shared...
  - snowpack, soil moisture, groundwater (GP), evapotranspiration

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# Summary

- Short-term Water Management Needs
  - CCAWWG Report describes community needs related to improving hydroclimate information (monitoring + forecasting) and how we make use of it ([www.ccawwg.us](http://www.ccawwg.us))
  - Reclamation R&D and Regions are investing in efforts to address various needs, but a community response will be required to fully realize improved prediction skill and/or approaches for making use of available hydroclimate information
- NOAA-Reclamation Drought Meeting  
November 6-7, 2012
  - Users interested in enhanced hydrologic monitoring + improved prediction (seasonal runoff; sub-seasonal climate and runoff during spring)