CBRFC Water Supply Forecasting: What Does the Future Hold?

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CBRFC Stakeholder Forum
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Outline

The Past: A Brief Recap

The Need for Change: Stakeholders, Science, and Verification

The Future: Perspectives and Direction
• Science and Stakeholders
The Past

SWS (Statistical Prediction)
ESP (Hydrologic Model Prediction)
VIPER (Statistical Prediction)

Official Coordinated Forecast

Decision

Other Inputs

Water Managers and Users
Methods

- **Statistical Forecasting**
  - Statistical Regression Equations
  - Primary NOAA/RFC forecast method from 1940’s to mid 1990’s.
  - Primary NRCS/NWCC forecast method
  - Tied to a fixed runoff period (inflexible)

- **Ensemble Simulation Model Forecasting**
  - A component of a continuous conceptual model (NWSRFS)
  - Continuous *real time* inputs (temperature, precipitation, forecasts)
  - Accounts for soil moisture states (SAC-SMA) - drives runoff efficiency
  - Builds and melts snowpack (Snow-17) – output feeds SAC-SMA
  - Flexible run date, forecast period, forecast parameters.
  - Evolving toward ESP as primary forecast tool at NOAA/RFCs
Past Output

Forecast attributes:

- Target: seasonal volume (typically April-July)
- Frequency: monthly or semi-monthly during winter/spring
- Probabilities: 10, 50, 90% forecast exceedence
- Format: email, publication, and web site
- Other tools: online toolsets
- Coordination with NRCS
The Need to Change

Past practice:
• Not conducive to more frequent (daily/weekly) updates
• Not conducive to ensemble based forecasts
• Coordination and manual combination does not systematically add skill (see verification)
• Forecast process not repeatable
• In spite of some success, integration of new science is difficult

New practice should:
• Leverage NOAA/NWS expertise with weather and climate prediction
• Leverage CBRFC daily forecast operations
• Leverage CBRFC forecaster expertise
• Provide short to long term forecast information including ensembles
• Ease ability to integrate new science, methodology, and technology
The statistical models are deficient in several aspects:

1. The forecasts are for monthly or seasonal volumes and do not provide day-to-day values or allow frequent updates.

2. The models do a poor job of predicting flows for extreme conditions that have not been observed historically.

3. The models do not account for large variations from normal in both temperature and precipitation that may occur subsequent to the date of the forecast.

4. These techniques are not amenable to easy changes (i.e., additional data or changes in data sources require complete recomputation).
Forecast Verification

Key Questions:

• How accurate is each forecast tool?
• How reliable is each forecast tool?
• How do these answers change over time or space?
Verification Strategy

- Systemic answers require large number of forecasts
- Use reforecasts to have a large sample size
  - Reforecasts use current calibrations to simulate past forecasts
  - Do not (yet) incorporate weather forecasts (which would make it better)
Metrics Explained

- **Accuracy:** Forecast - Observed
- **Reliability:** Relationship of observed to forecasts
January 1
50% Forecast Accuracy
ESP more accurate in 74 of 98 cases
April 1
50% Forecast Accuracy
ESP more accurate than SWS in 78 of 98 points.
Forecast Reliability

January Reliability Plot for BMDC2

April Reliability Plot for BMDC2
Forecast Reliability

Ok; But how does reliability of forecast system vary over all points?

\[ |A| + |B| + |C| + |D| \]

Gives a measure of total reliability.
ESP more reliable at 29 of 98 points. ESP and SWS equally reliable at 10 points.
For April 1, ESP more reliable than SWS in 48 of 98 points
Across Lead Times

**Accuracy**

**Reliability**

- **Skill Score**
  - ESP
  - SWS

- **Reliability**
  - ESP
  - SWS
Werner et al, 2004 compared ESP forecasts with 14 days of probabilistic weather inputs with ESP based on pure climatology. Showed that ESP with weather outperformed ESP without weather.
Verification Summary

- Across all points for January 1:
  - ESP significantly more accurate than SWS
  - SWS slightly more reliable than ESP

- Across all points for April 1:
  - ESP generally more accurate than SWS
  - SWS slightly more reliable than ESP

- Inclusion of weather probabilistic weather forecast improves ESP accuracy by 10-40% during melt season.
New Direction (NOAA/NWS)

- NWS RFCs are no longer coordinating forecast numbers with NRCS (informal coordination is important and will continue). For CBRFC stakeholders in WY13, there will be two different forecasts available.
- NWS RFCs are moving toward:
  - Daily updating ESP forecasts
  - Routine integration of weather and climate forecasts
  - Full season and residual forecasts
  - Short to long lead ensemble forecasts
  - Verification and reforecasts to quantitatively assess forecast skill
  - Backward compatibility for key forecast products (e.g. emailed products)
What does this mean for CBRFC?

- Continuation of text forecast products to support water management

- Discontinuation of water supply forecast publication

- Redeployment of forecast expertise from concentrated effort during first week of month toward more continual monitoring and adjustment of forecast skill.

Key benefits:

- Daily updating forecasts
- Quick turn-around on monthly forecasts
- Documentation of forecaster modifications to ESP
- Access to ESP traces
- Overhaul of Peak Flow Forecasts

Note: We don’t expect forecast skill to increase based on this direction alone
How do you currently access CBRFC water supply forecasts?

- Email / Text Product
- Publication
- Website
- USBR 24 month study
- Other?
Examples

Example Log:
1/25 – Forecast problem
2/1 – SWS forecast is 600 KAF
3/1 – ESP biased high according to bias statistics; official forecast 10% lower.
3/2 – Snow update (forecast increase)
3/10 – Major QPF event on day 5

Download forecasts, traces, etc.
## Examples

Weekly ESP for COLORADO - LAKE GRANBY, GRANBY, NR (GBYC2)

Data are provisional. Please contact CBRFC with questions or for clarification.

### Input Options:
- NWS ID: gbyc2
- Number of Forecasts: 25

### ESP Raw Model Guidance (Exceedance kaf)

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Your input is key!

• Does paradigm described meet your needs? Why or why not?
• QPF vs no QPF?
• Forecast horizon?
• Seasonality of issuance?

• Feedback requested by August 15