Supporting Reservoir Management Through Hydrologic Forecasting Services in American River Basin

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BIOGRAPHICAL SKETCH

Brett Whitin has been a National Weather Service hydrologic forecaster for the past six years – the first three being at the Southeast River Forecast Center, and the past three at the California-Nevada River Forecast Center. Prior to his time with the National Weather Service, Mr. Whitin worked as a hydraulic engineer for the U.S. Army Corps of Engineers - Sacramento District. Mr. Whitin has a BS (1997) and MS (1999) in Civil Engineering from Clemson University, and is a licensed engineer in the state of California.

Work:  
National Weather Service – California-Nevada River Forecast Center (2010 – present)

ABSTRACT

The California-Nevada River Forecast Center (CNRFC) has recently expanded its hydrologic services in the American River Basin to assist reservoir management decision support. A total of six new sub-basins have been created to support the needs of the Sacramento Municipal Utility District (SMUD) and Placer County Water Agency (PCWA). Both real-time deterministic and ensemble forecast products are being utilized by SMUD and PCWA to assist in short and long-range reservoir management decision making. This newly developed model is also being used to support the Folsom Joint Federal Project (JFP) water control manual update. The CNRFC is working closely with the JFP multi-agency team to develop procedures that utilize hydrologic model antecedent conditions and meteorological forecasts to establish dynamic flood control requirements.
Collaborative Projects

- **SMUD & PCWA**
  - additional forecast locations
  - expansion of products

- **US Army Corps of Engineers**
  - integrate use of CNRFC products into new Folsom water control manual
    - a) upstream reservoir information
    - b) current soil/snow states (i.e. antecedent conditions)
    - c) forecasts
American Basin 2011
9 Watersheds & 12 Subareas
American Basin 2012
15 Watersheds & 24 Subareas
Products

- deterministic forecast
- ensemble hourly flows out 10 days
- ensemble daily flows out 365 days
Folsom Water Control Manual

Collaboration

• **Upstream Reservoirs**
  - French Meadows, Hell Hole, Union Valley, Ice House, Loon Lake

• **Basin Wetness**
  - soil moisture accounting model information

• **Forecasts**
  - short to medium range meteorological information
Initial Sensitivity Study

- Determine significance of “basin wetness” on large rainflood events
  - use NWS-CNRFC operational models
  - compare volume differences between wet and dry conditions
Methodology

- Simulate 1997 event using 1977 conditions
- Simulate 1986 event using 1977 conditions
- Simulate 200-yr event using 1977 conditions
Folsom Watershed Topology
SAC-SMA CATCHMENT MODEL STRUCTURE

Fast Response (Surface, Impervious and Direct Runoff, and Interflow)

Slow Response (Supplemental and Primary Baseflows)

Maximum and Actual Parcipation Rate Calculations:

1. Capillary System Flow: SAC-SMA variable; FLZSFR (Lower Zone Saturated Flow Rate)

2. Gravity Flow: Upper Zone Free Water Weight:

Primary Baseflow

Supplemental Baseflow

Additional Surface Runoff

Direct Runoff

Surface Runoff

Interflow
Selection of 1977 Dry Conditions
(Upper Watershed of the North Fork)
North Fork 1977 Conditions
(Lower Elevations)
Dry conditions initiated prior to heavy precipitation spanning about 8 days
### 1997 Event Initial Condition Comparisons

<table>
<thead>
<tr>
<th>Condition</th>
<th>Max 1 day flow (cfs)</th>
<th>Max 3 day flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997 Hist Simulation</td>
<td>226,000</td>
<td>162,000</td>
</tr>
<tr>
<td>1997 Dry Simulation</td>
<td>104,000</td>
<td>80,000</td>
</tr>
<tr>
<td>% Reduction</td>
<td>54%</td>
<td>51%</td>
</tr>
</tbody>
</table>

![Graph showing FOLC1 Mean Daily flow comparison](image-url)
Soil Zone Comparison
1986 Event

- initial conditions drier than in 1997
- heaviest precipitation period was also 8 days
- similar 3-day volume differences as 1997 (50%)
200-yr Construct

- Used 1997 data as basis
- Temperatures left the same
- Basin average precip iteratively scaled up until 200-yr average three day flow was met (235,000 cfs)
- Resulted in a precip scaling factor of 1.4
200-yr Results

- 3-day volume reduction of about 35%
- not as substantial as the 1997 and 1986 events
- initial conditions become less influential as precipitation increases
Sanity Check

• Columbus Day 1962 Event (Oct. 12)
  • 3-day flow was about 38,000 cfs

• dry conditions with comparable precip to 1997
  • Oct 1962 had 15 inches fall in 4 days
  • 1997 event had 14 inches in 4 days
Period of Record Results
(1948-2010)

WY 1986 200yr
3-day volumes
Water Year 2008
Water Year 2012
Next Steps

• Generate seasonal storm adjustments for fall and spring
• Reservoir modeling to determine required flood storage for given inflow volume
• Derive basin wetness adjustment equations
• Use this information to formulate basin wetness indices
• Incorporate forecasts