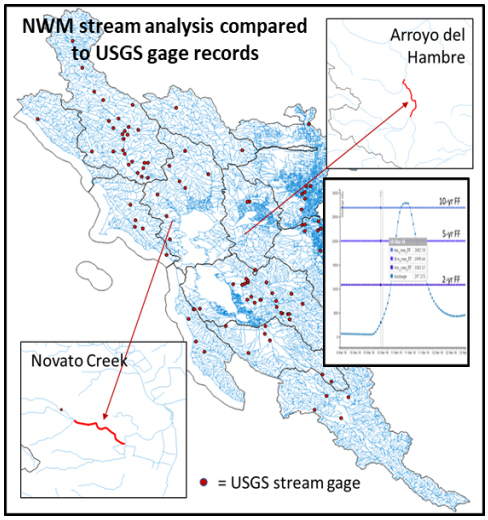
AQPI - TRIBUTARY HYDROLOGIC MODEL UPDATE – OCTOBER 2019

AQPI Hydrologic Forecasting Model Description

The AQPI project is using the NOAA National Water Model (NWM) as the tributary hydrologic forecast tool. The NWM is a distributed hydrologic model that simulates observed and forecast streamflow over the entire continental United States (CONUS). The NWM computes the hydrologic balance on a 250 m grid, aggregates excess precipitation to a 1 km grid, and routes these flood flows using the NHD-PlusV2 stream network. The system updates to include USGS gaged flows (-3 to 0 hrs), along with three forecast configurations (short- (0 to 18 hrs; 1-hr update), medium-range (0 to 10 days; 6-hr update) and long-range (0 to 30 days; 1-day update). All model configurations provide streamflow for ~11,000 stream segments in the SF Bay area which can be interrogated to obtain forecast flow hydrographs. Real-time forecasts by the NWM can be found at https://water.noaa.gov/.



AQPI Tributary Hydrologic Model Products

A variety of watershed hydrologic information products are anticipated for the AQPI system. Using the new capabilities for detecting and tracking coastal storms and forecasting precipitation, the AQPI Tributary Hydrologic Model will provide high-resolution forecasts of flows at each of the 11,000 stream reaches. Flow hydrographs will show the timing of peak flows and the associated flood frequency levels for each reach. Other products include maps of soil moisture saturation and locations of at-risk bridges. The coupled coastal model will show inundation depths for SF Bay estuaries. More details on the NWM and its products can be found here.

In addition, it is intended that the AQPI incorporate local agency data, such as ALERT system precipitation and stream gage data, and to support local agency flood warning procedures. For example, the Contra Costa Flood Control Agency has developed the so- called 7-5-3-2 application which tracks the antecedent and forecast rainfall amounts for sectors of the county and compares these to established threshold levels keyed to flood threats (see https://www.contracosta.ca.gov/4923/Flood-Forecast-Tool).

Projected Average by Thu Nov. 23 - 10:00 PM	Year to Date+ (inches)	Avg 30 Days+ (inches)	Avg 7 Days+ (inches)	Avg or Max 24-hr Rainfall Forecast+ + (inches)
Compare to Protocol:	***7.00***	***5.00***	***3.00***	***2.00***
Highlighted if current Average Data + Average Cum. Forecast meets Protocols	3.50	3.36	2.51	0.25

Based on Average of Maximum Gauge Readings

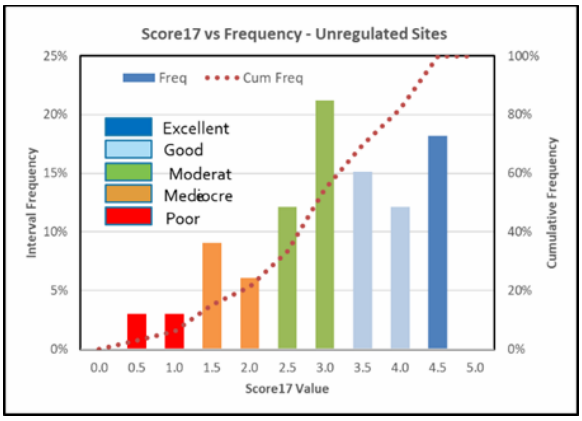
AQPI Tributary Hydrologic Model Performance

Demonstration of the accuracy and usability of the NWM products is a prerequisite before it can be used with confidence by flood mitigation and water resources managers. Two assessments were conducted to characterize how well the NWM performs, 1) retrospective simulation for the period 2013 – 2017, and, 2) forecast assessment for February – March 2019.

Retrospective Simulation Assessment

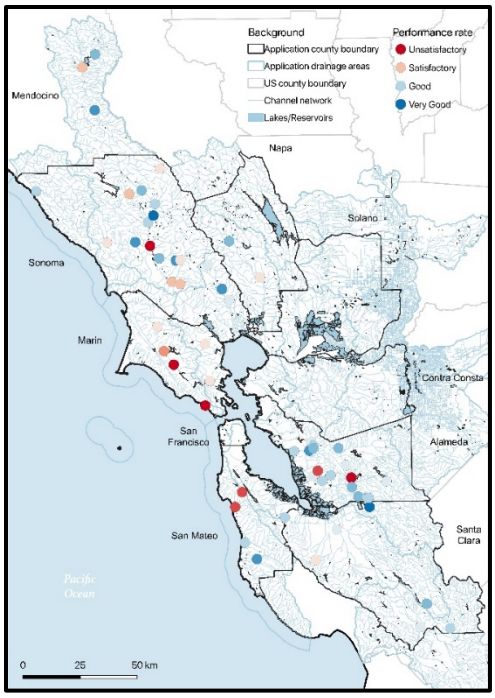
The retrospective simulation results involved comparison of NWM using archived rainfall data with USGS gaged flows at 47 locations (see map on previous page). Statistical metrics were combined to a 1 to 5

scale called “Score17”; 1 -2 = Poor, 4 – 5 = Excellent. For the 32 unregulated sites having little influence of reservoirs, 78% were rated Moderate or better, 50% were rated Good or better, and 16% were rated Excellent; performance at the remaining 22% was rated poor or mediocre (Figure right). The regulated sites did not do as well but some still showed useful performance.



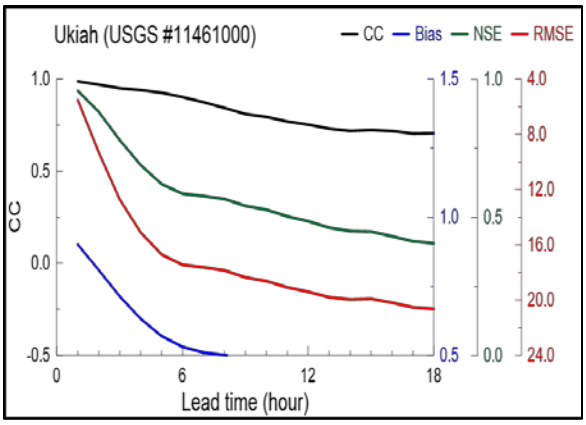
Aside from reservoir regulation effects, a major factor for poor or mediocre performance was attributed to poor rainfall mapping, either too much or too little. More details on the retrospective assessment can be found here (Summary, Ppoint or Report).

A related assessment of NWM performance was conducted for the entire period 2013 to 2017 using a Hydrologic Assessment Tool (HAT). The approach involved a combination of machine learning and clustering analysis to provide an assessment of NWM performance divided into 4 categories; the figure Illustrates hydrograph shapes characterized as a) Very Good (VG, top row), b) Good (G), c) Satisfactory (S) and d) Unsatisfactory (US, bottom row). Red and blue lines are the simulated and observed hydrographs respectively. The NWM was shown to perform G-VG for at least 46% of the hydrographs examined during from October 2013 to February 2017, regardless of the watershed size. More details on the HAT assessment can be found here (Summary, or Report).



Forecast Assessment

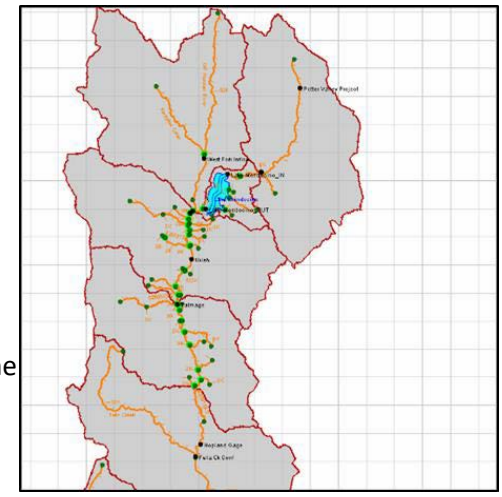
Assessment of NWM forecast skill was conducted for the Feb. – March 2019 period for three locations in the upper Russian River basin. The figure (right) shows the variations of the statistical metrics versus lead time out to 18 hours for the USGS gage Russian River nr Ukiah. The metrics are Correlation Coefficient (CC), Relative-bias (BIAS), Nash-Sutcliffe Efficiency (NSE), and Root Mean Square Error (RMSE). As would be expected, all metrics improved as lead time decreased, especially at less than 6 hours. Similar results were found for the other two gage sites in the Russian River watershed. More information on the NWM forecast assessment can be found here (Summary or Ppoint).



We conclude that given accurate precipitation forecasts, the National Water Model does a good job at forecasting the timing and intensity of streamflow at

the 3 sites. NWM performance was generally acceptable at 18 hours lead time, and gradually improved as lead time decreased.

Reservoir Operations



The influence of reservoir regulation impacts performance. To reflect downstream regulation effects requires local implementation of reservoir operations models; this is being examined by two county agencies. A case study description on linking the NWM to a reservoir operations model was conducted for the upper Russian River basin involving Lake Mendocino. An integrated water management model, NWM-ResSim, was formulated through coupling the NWM with a reservoir operation simulation model, HEC-ResSim. The approach involved refining the ResSim model structure to reflect the nodal structure of the NHD-Plus stream network. The evaluation results suggest that the NWM-ResSim improves the estimates of outflow from this managed reservoir over the default NWM reservoir representation scheme. Active involvement of operators in posting release schedules to an accessible database is recommended. More information on this project can be found here (Ppoint or Report).

All supporting documents can be accessed at:
https://drive.google.com/open?id=1vhrSITcSPum9DPL9nmt8g0SFR5X9kq3z