NOAA’s Colorado Basin River Forecast Center

The National Weather Service’s River Forecast Centers – Who We Are and Our Role in Dam Safety

Paul Miller
Service Coordination Hydrologist
DOI Dam Safety and Security Training
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River Forecast Centers provide a broad array of products and services, including short-term forecasts, peak flow forecasts, and seasonal water supply forecasts

- Data and coordination is extremely important
- Every RFC is different, but all provide decision support and welcome stakeholder engagement
- Western RFCs are particularly adept at seasonal water supply forecasting

RFCs are a great resource for dam safety information and implementing of emergency action and safety plans
Overview

• What and Who are River Forecast Centers
• Summary of key operations, products, and services
• Services available during a dam incident or failure
River Forecast Centers

- 13 RFCs nationwide
  - Co-located with a subset of the 122 Weather Forecast Offices (WFOs)
  - Support NOAA’s hydrologic services and products
- Focused on decision support
- Western RFCs are particularly adept at water supply services
River Forecast Centers

• Work with a broad and diverse set of stakeholders
  – Federal agencies (e.g. Reclamation, USACE)
  – Municipal and Agricultural Water Users
  – State, academic, NGOs

• Data consumers – we rely on information provided by many of our stakeholders
River Forecast Centers

- WFOs are a key stakeholder
  - WFOs issue Flood watches and warnings based on RFC guidance
  - Flexible support abilities
  - Provide actionable, risk-based, information

- WFOs coordinate with emergency managers and public in their local areas
Water Supply Forecasts

- Probabilistic, volume forecasts
- Updated daily, with monthly “official” forecasts
- Monthly and seasonal time steps
- 1 – 5 years into the future
- Used by Reclamation in reservoir operations model, and other water managers
We use a hydrologic model (Sac-SMA) coupled with a snow accumulation and ablation model (SNOW-17) to develop forecasts.

- Calibration is highly dependent on gage observations.
- Calibrations vary between RFCs, so make sure you contact your RFC of interest for more details!
Our models

SNOW-17

Flowchart of the SNOW-17 Model

Precipitation

Evapotranspiration

Upper zone

Pervious

Impervious

F: Free water
T: Tension water

Infiltration

Percolation

Interflow

Surface runoff

Direct runoff

Evapotranspiration

Lower zone

Primary

Suppl.

Reserved

Rain or Snow?

Accumulated Snow Cover

Energy Exchange at Snow-Air Interface

Areal Extent of Snow Cover

Deficit=-0.0

Lined Water Storage

Transmission of Excess Water

Rain on Bare Ground

Snow Cover Heat Deficit

Ground Melt

Rain Plus Melt

Snow Cover Outflow

Reserved

Baseflow

Subsurface outflow
Gage data is really at the heart of what we do. Quality data allows us to make accurate forecasts; without it, our forecasts have significantly more uncertainty.

We spend a significant amount of time on data quality control.
Forecast Data is Vital

- Short term skill limitations
  - Dependent on skill in weather forecast
  - Knowledge of planned operations (e.g., reservoir operations and use)
Developing a Forecast

Observed Data from USGS

Temperature and Precip Information

Official forecast
Developing a Forecast

Observed Data from Reclamation

Official forecast
Developing a Forecast

• Forecasters analyze historical and future precipitation and temperature information
• Utilize observations to assess model performance
• Make any adjustments (snow, diversions, etc...). We refer to these as “modifications” or “mods”
• This is done at least once per day
Developing a Forecast

- Products are published to our websites and communicated to stakeholders in a variety of ways.
- Information provided by each RFC is presented slightly differently, but generally available!
Roles of Forecasts in Decision Support

- NOAA/NWS
- Decision Support Model
- Decision Maker

Forecasts (single-value or probabilistic) → DS Model

- processed outcomes
- estimate risk of outcomes based on specified decision
- if outcomes are unacceptable specify new decision

NOAA/NWS
Decision Support Model
Decision Maker
Forecasts (single-value or probabilistic)
Role of Forecasts in Decision Support

Typical Reservoir Operations

- Reservoir Inflow Forecasts
- Reservoir Model
- Decision Support Model
- NOAA/NWS
- Decision Maker

**Forecast Pool:**
- Forecast pool elevation/elevations

**Threshold Exceedance Probabilities:**
- Based on a specified release strategy

**If Outcomes are Unacceptable:**
- Specify new release strategy
Role of Forecasts in Decision Support for Reservoir Operations

NOAA/NWS

Decision Support Model

Decision Maker

Reservoir Inflow Forecasts

Reservoir Model

forecast pool elevation/elevations

threshold exceedance probabilities based on a specified release strategy

if outcomes are acceptable, send new release strategy to NWS

Downstream River Forecasts
NWS Role Before Potential Dam Failure

- WFOs and RFCs are available to contribute to tabletop exercises and other planning events.
When there is the potential for a Dam Failure

- Contact your local WFO immediately. If the relationship isn’t there now, let’s build it
- WFO will issue an appropriate watch or warning and coordinate with emergency managers
- WFO will coordinate with the appropriate RFC to provide support during the incident
- Disseminate information to public
Role of RFCs during a Dam Incident and Flash Flooding

We can provide quantitative estimates based on information we have catalogued in our database – but we need to have the information!

This is an internal product that we use – not available publicly
Role of RFCs during a Dam Incident and Flash Flooding

Erosion threatened the integrity of the emergency spillway at Lake Oroville following heavy rains in Feb. 2017.

NWS issued a Flash Flood Warning for downstream locations on Feb. 12th, 2017.

While the NWS has tools for estimating flows and travel times associated with dam breaches, we had no tools for producing such estimates for an emergency spillway structural failure.

As per CA Department of Water Resources:
- Officials now anticipate a failure of the Auxiliary Spillway at Oroville Dam within the next 60 minutes.
- Residents of Oroville should evacuate in a northward direction such as towards Chico.
Role of RFCs After a Dam Incident and Flash Flooding

- NWS will be heavily involved in post-disaster recovery
  - On site support
  - Localized weather/river forecasts
- RFCs can develop custom products and services to meet stakeholder needs
National Water Model
Improving NOAA's Water Prediction Services

In August 2016, NOAA took a giant leap forward in its ability to forecast the flow of rivers and streams throughout the entire continental United States with the launch of the new high-resolution National Water Model (NWM).

The NWM will enhance and expand NOAA's water flow forecasts, which to date have been available for approximately 4,000 river locations with stream gages operated by the U.S. Geological Survey. This new model will expand forecasts to 2.7 million stream locations nationwide. Leveraging the full network of nearly 8,000 U.S. Geological Service stream gauges and NOAA's investment in atmospheric modeling, the NWM will provide high-resolution forecasts of soil moisture, surface runoff, snow water equivalent, and other parameters.

Initially, this new NWM-based information will be particularly useful in headwater areas in support of NOAA's flash flood mission.

**How it Works**

The NWM simulates the water cycle with mathematical representations of the different processes and how they fit together. This complex representation of physical processes such as snowmelt and infiltration and water movement through the soil layers varies significantly with changing elevations, soils, vegetation types and a host of other variables.

Additionally, extreme variability in precipitation over short distances and times can cause the response on rivers and streams to change very quickly. Overall, the processes are so complex that to simulate it with a mathematical model means that it needs a "supercomputer" in order to run in the time frame needed to support decision makers when flooding is threatening.

www.water.noaa.gov
Conclusions

• RFCs can be a great resource and partner for your agency, and can provide information to drive your decision support tools

• Regarding dam safety
  – Can provide quick, quantitative values if information is available
  – Highly dependent on data and current EAPs
  – Engage your WFO and RFC to identify gaps, if any, and work to fill them
NWRFC – Steve King:  stephen.king@noaa.gov
CNRFC – Alan Haynes: alan.haynes@noaa.gov
CBRFC – Paul Miller: paul.miller@noaa.gov

If you are interested in another region, contact me and I’ll get you in touch with the right person