Pseudo-Hydrologic Forecast for Climate Change and Other Alternative Hydrology

Presenters

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Motivation of Developing Hydroforecast DLL

SWP contractors need an analysis tool to evaluate their allocation procedures for the water allocations and its associated risks in response to various September reservoir carry-over storage rules, hydrologic uncertainties, and timing of allocation decisions.

[Hongbing Yin]

Background

- **Monthly Unimpaired Flow** at key reservoirs and streams in the Central Valley significantly influences **SWP and CVP allocations, Delta operations, and water year type classifications** through Sacramento and San Joaquin Valley indices.

- State water contractors need **to evaluate the system response (water allocation)** to different reservoir carryover storages and different risk levels of reservoir inflows.

- **CalSim 3** a water resources planning model **requires forecasted flow at various exceedance levels** to **simulate forecast-based operations** of SWP, CVP, and water infrastructure in the Central Valley and Sacramento-San Joaquin Delta.

- DWR Bulletin 120 (B120) started publishing the **median monthly flow forecasts for the rest of the water year in the beginning of February, March, April, and May** from 1969 and gradually expanded the forecasts into other exceedance levels.

DWR B120 Forecast Development

- Monthly flow forecasted started from 1969 –
- **Hybrid forecast method**
  - Statistical + Engineering judgement and manual adjustment
- **Data used in the forecast**
  - Precipitation, snowpack, historical unimpaired flow records, and other basin information

BDO Hydroforecast Development

- Use the data that are available for **the entire simulation period** (WY 1921-current).
- Statistical method only.
- Exceedance Levels: 50%, 75%, 90%, and 99%.

BDO Hydroforecast DLL

- **Forecast validation** was made against the **historical unimpaired flows** as well as with **the B120 forecast**.
- Forecast made for the **entire simulation period** starting from WY 1922.
- **Automated monthly forecasts** on the fly for sequential model run and position analysis.
- May be reasonably applicable to most **climate change scenarios**.
- Depends on the historical condition and data. Needs **recalibration** if there is any **change** in the **input historical dataset**.

Locations and Unimpaired Flow Data Source

Sacramento Valley

1. **Feather River** inflow to Oroville
2. **American River** Inflow to Folsom
3. **Yuba River** at Smartville
4. **Sacramento River** Inflow to Shasta
5. **Sacramento River** at Bend Bridge

CEDEC

6. Unimpaired inflow to **Trinity Lake**
7. Unimpaired inflow to **Whiskeytown**

CS3 Rim Inflow

San Joaquin Valley

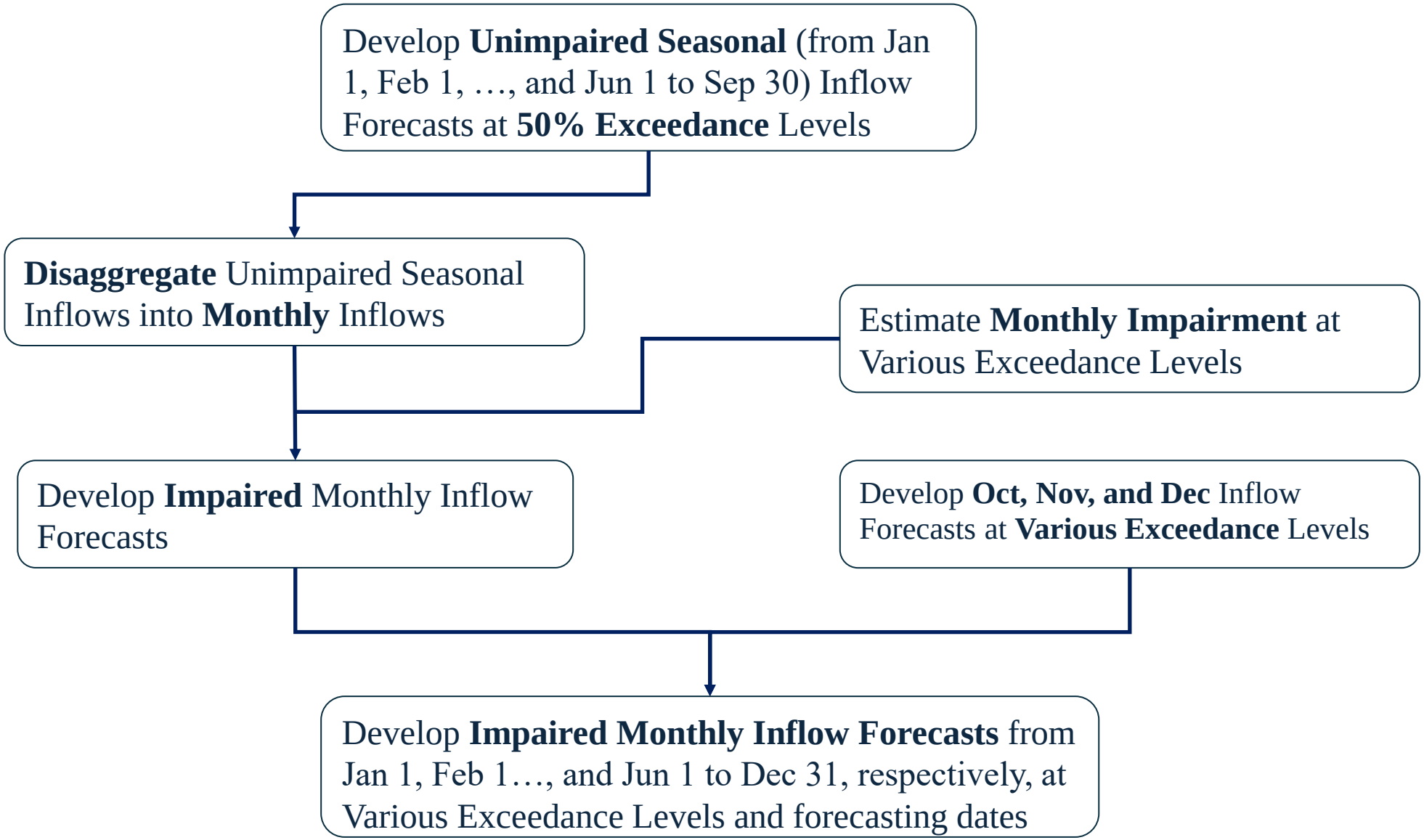
1. **Stanislaus River** below Goodwin
2. **Tuolumne River** below La Grange
3. **Merced River** below Merced Falls
4. **San Joaquin River** inflow to Millerton

CEDEC

Historical Data Used in Hydroforecast DLL

- ❑ Monthly unimpaired flow data from CDEC for all the locations except Trinity and Whiskeytown Lake.
- ❑ Basin Areal Averaged Precipitation - PRISM.
- ❑ Temperature - PRISM.
- ❑ Vapor Pressure Deficit - PRISM.

General Methodology



Development of Pseudo Forecast for Alternative Hydrologic Conditions

$$Forecasted\ seasonal\ flows_{\text{alt hydrl ,p (Jan-Sep)}} = Seasonal\ flow_{\text{alt hydrl (Jan - Sep)}} *$$

$$Forecasted\ seasonal\ flows_{\text{hist hydrl, p (Jan – Sep)}} / Historical\ seasonal\ flow_{\text{(Jan – Sep)}}$$

$$Forecasted\ monthly\ flow_{\text{alt hydrl, p (Jan)}} = Forecasted\ seasonal\ flows_{\text{alt hydrl, p (Jan – Sep)}}$$

$$* Monthly\ flow\ distribution\ coefficient_{\text{alt hydrl (Jan)}}$$

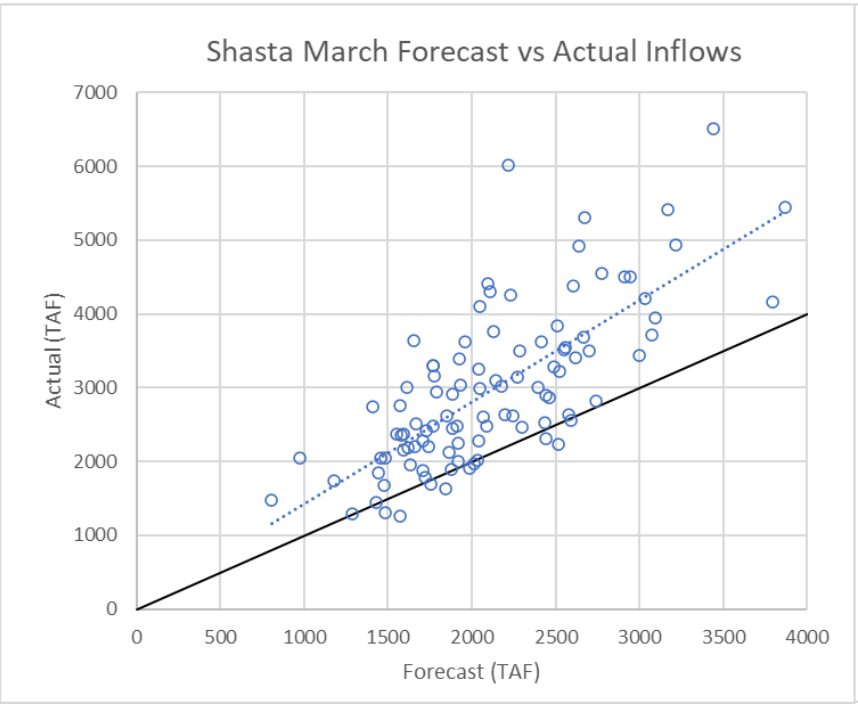
Evaluation of Results

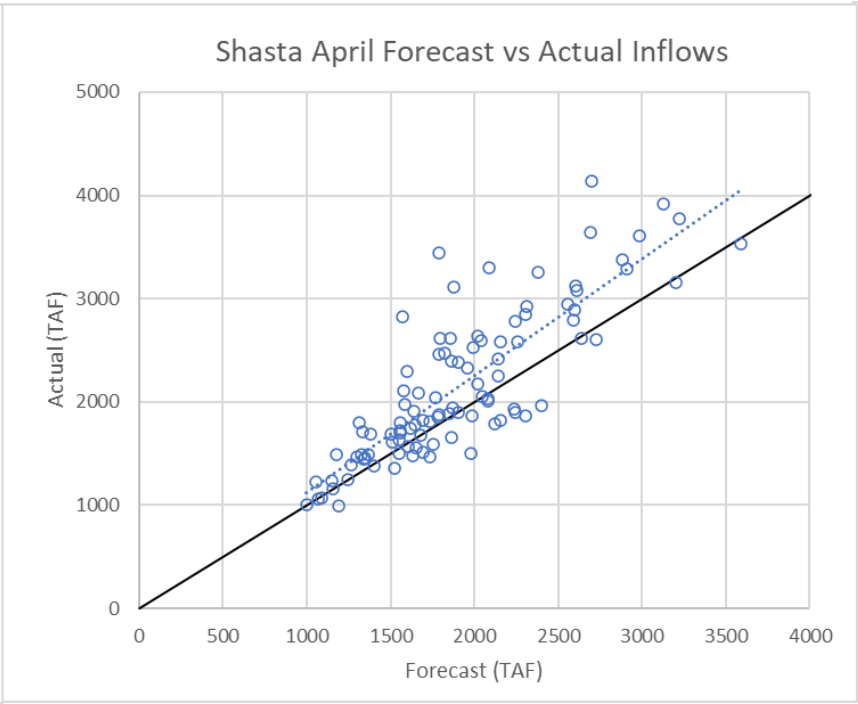
- Compare forecasted inflow with “actual” inflows
  - Forecast: Hydroforecast DLL output
  - Actual: unimpared inflows used for Calsim input
- Unimpared inflows
  - Historical data
    - Observed reservoir storage, stream gauges
  - Alternative hydrology
    - Developed based on historical data
    - 2022 MED from Reclamation’s LTO
      - projected inflows under climate change, 2022±15

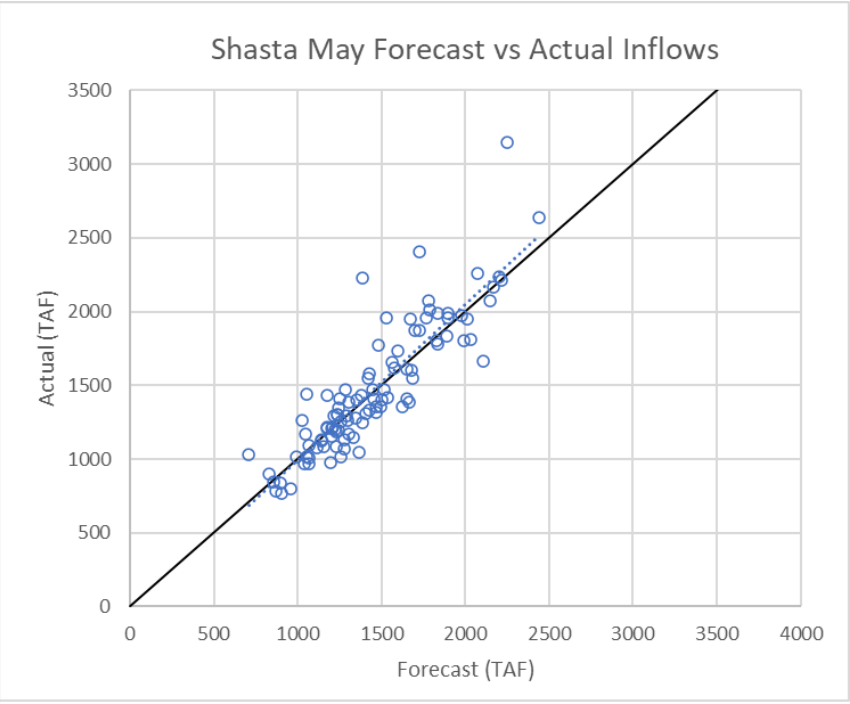
Shasta Historical

- Estimate of water supply
  - Total inflow from Mar/Apr/May – Sep
- More conservative estimates earlier in the year

	Nominal Exc	Exceedance
Mar	90%	90.0%
Apr	75%	71.0%
May	50%	46.0%



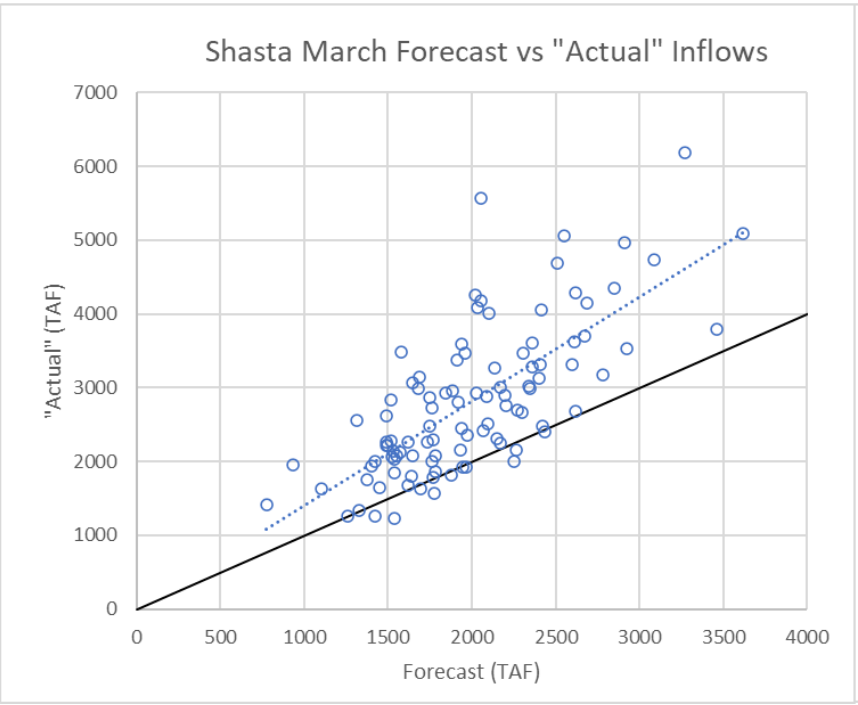


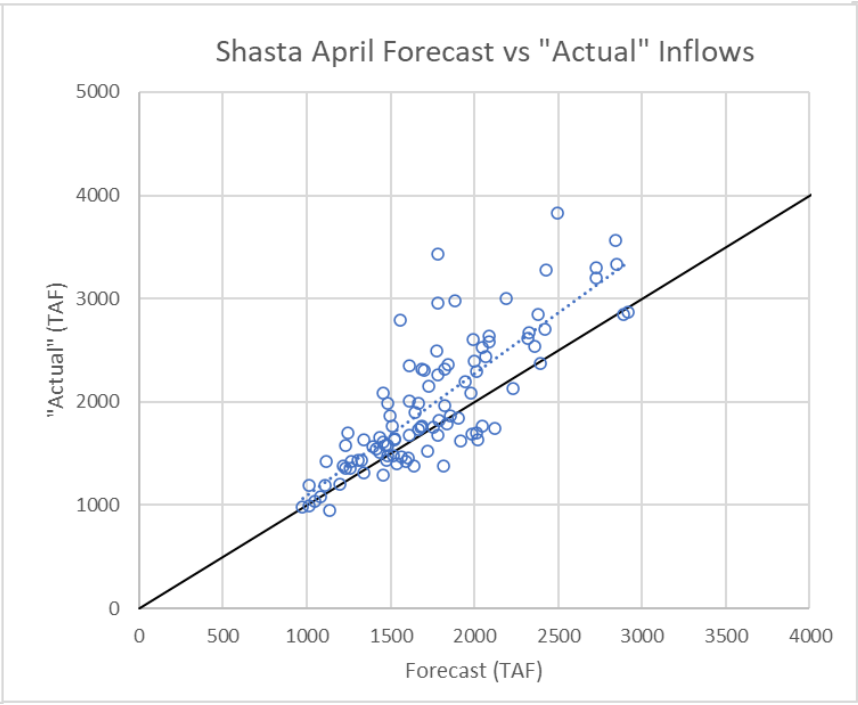


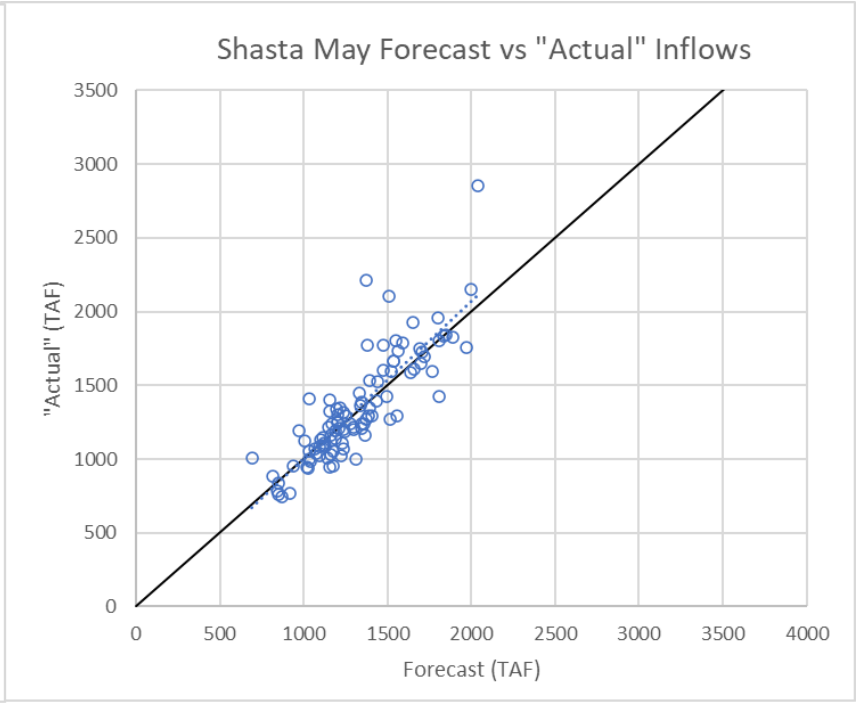
Shasta 2022MED

- Estimate of water supply
  - Total inflow from Mar/Apr/May – Sep
- "Actual" inflow – climate perturbed inflow
- Performance of forecasts for an alternative hydrology is similar to historical

	Nominal Exc	Exceedance
Mar	90%	90.0%
Apr	75%	71.0%
May	50%	46.0%



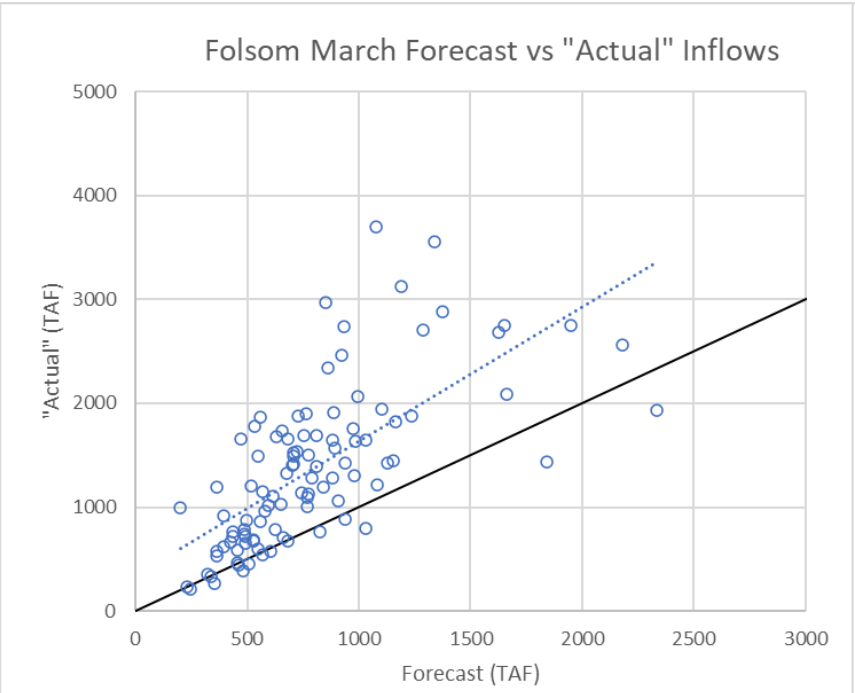


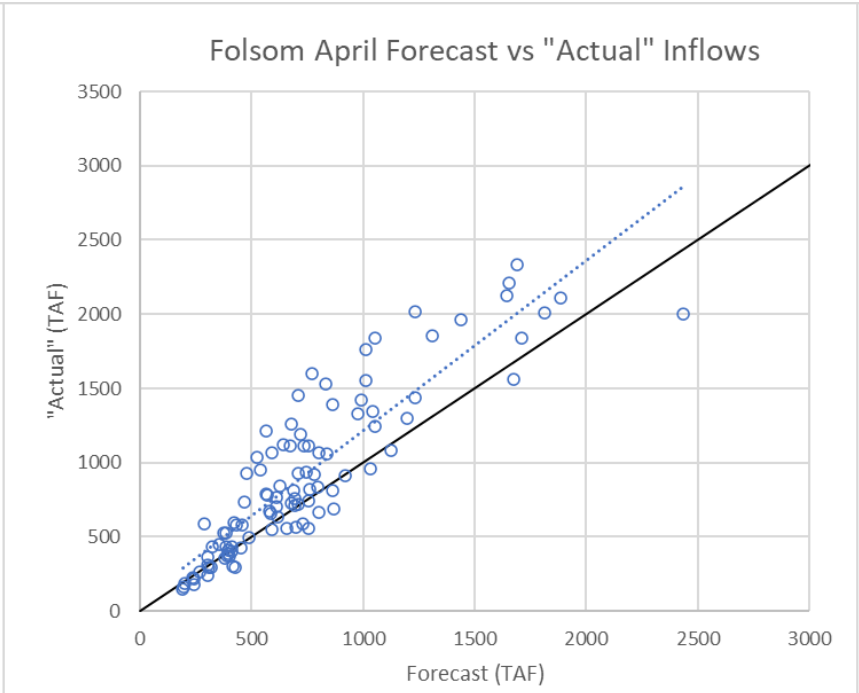


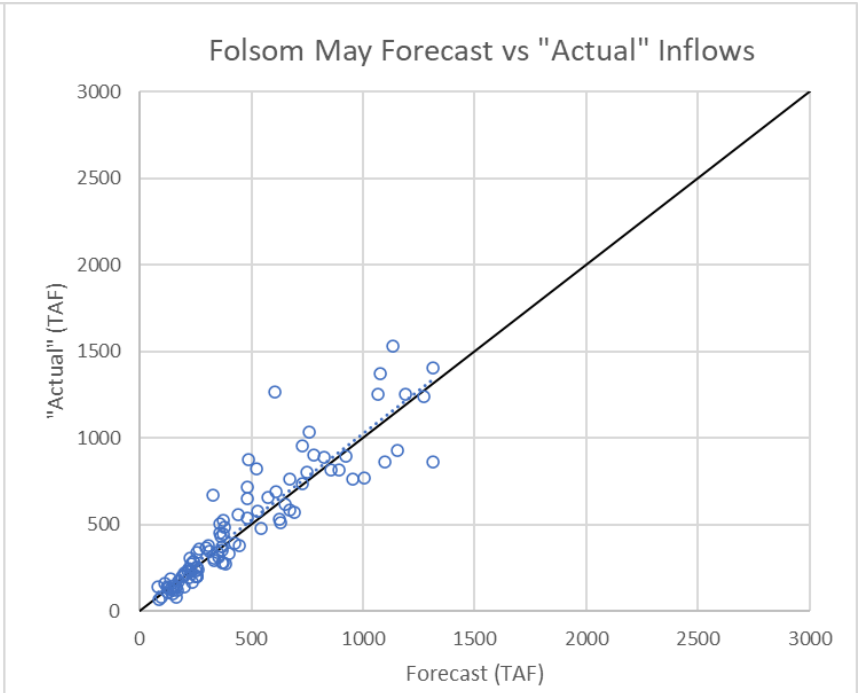
Folsom 2022MED

- Performance of forecasts for an alternative hydrology is similar to that of the historical

	Nominal Exc	Exceedance
Mar	90%	85.0%
Apr	75%	68.0%
May	50%	50.0%



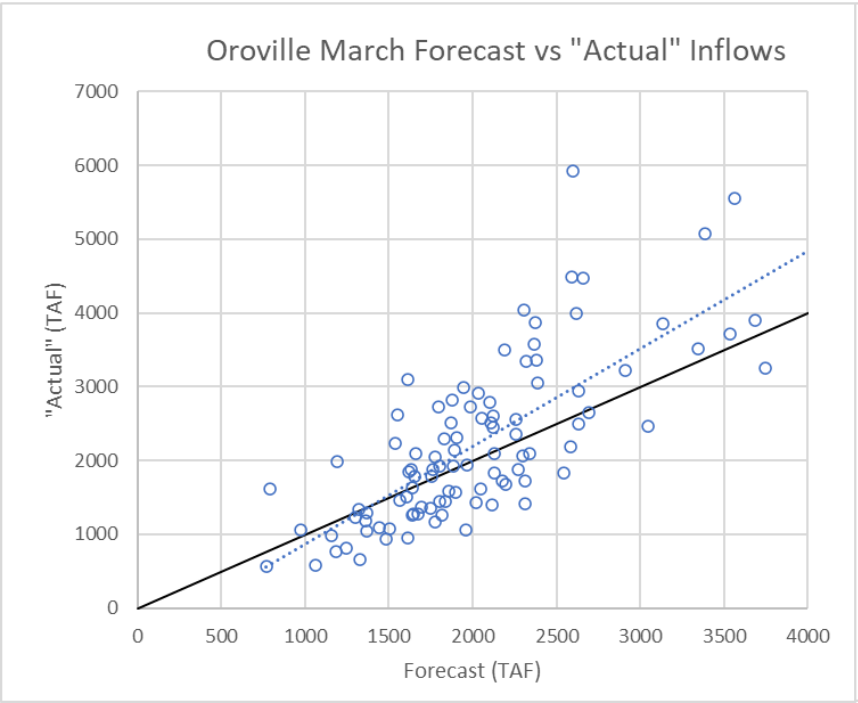


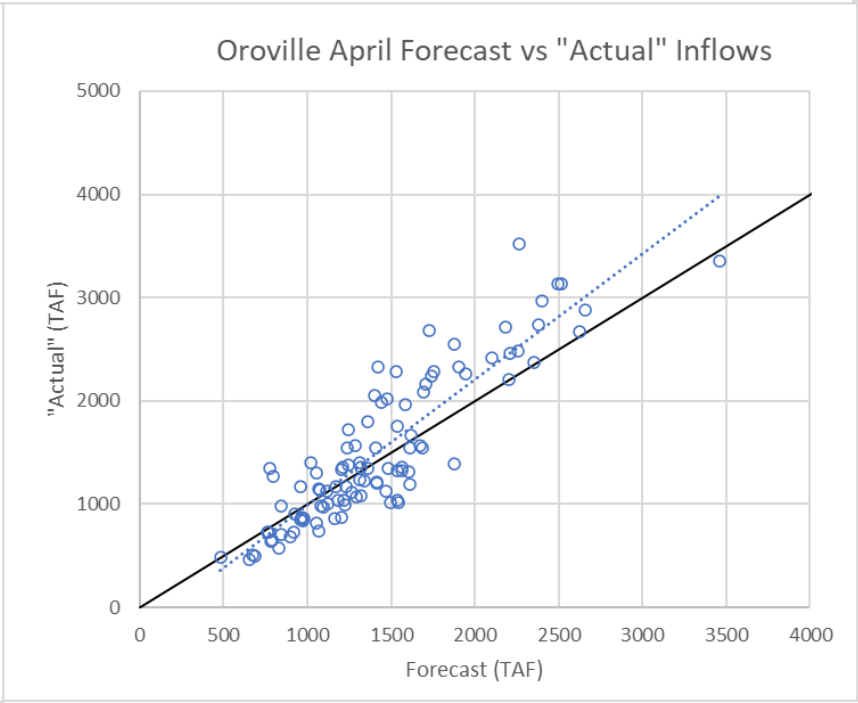


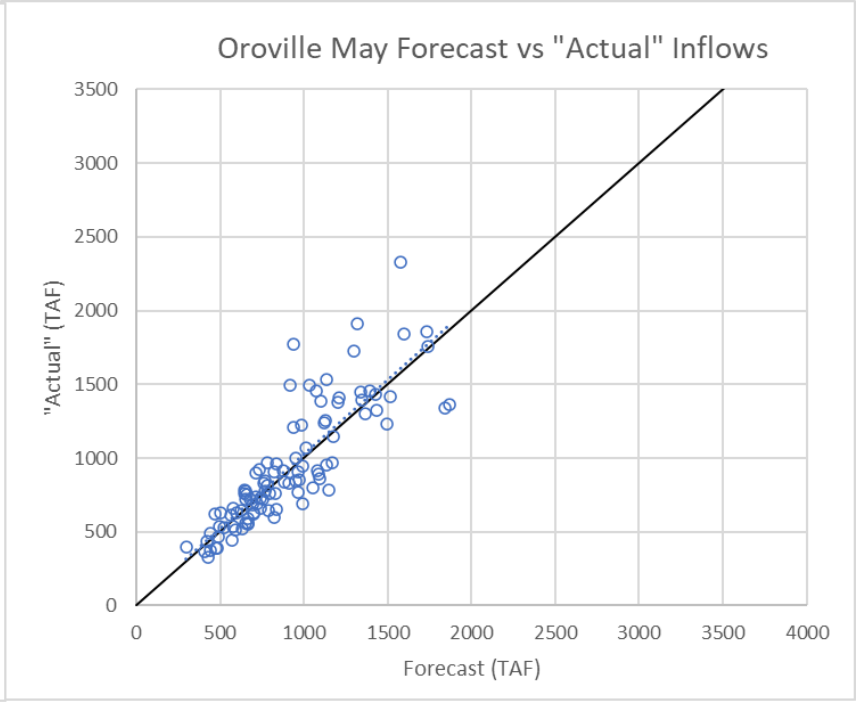
Oroville 2022MED

- Median inflow forecasts

	Nominal Exc	Exceedance
Mar	50%	52.0%
Apr	50%	50.0%
May	50%	52.0%



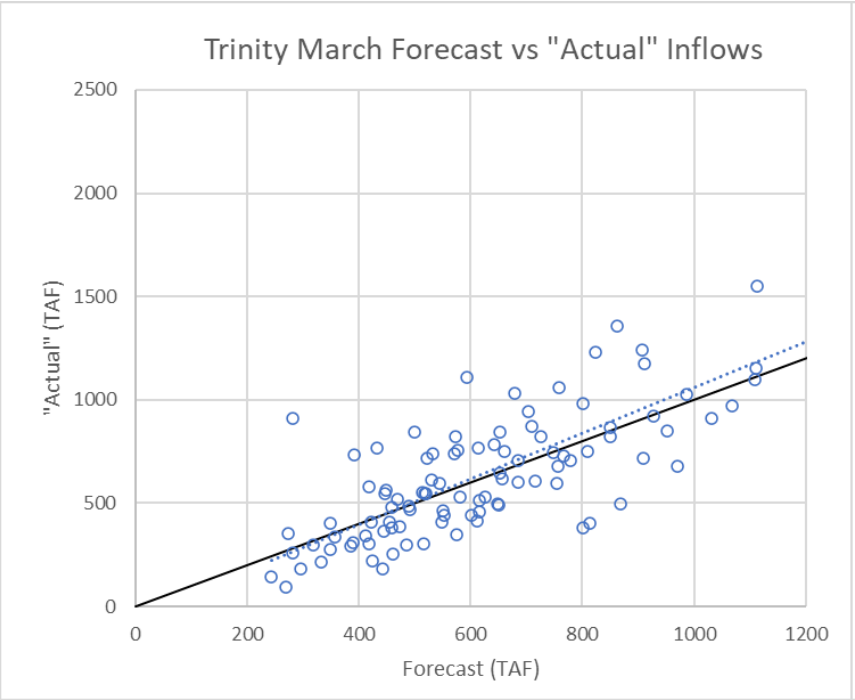


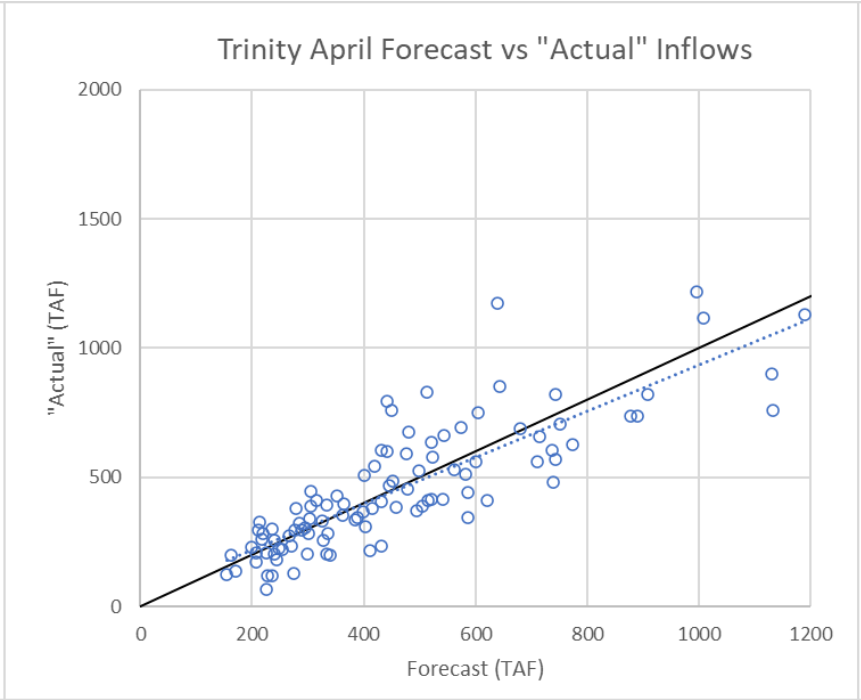


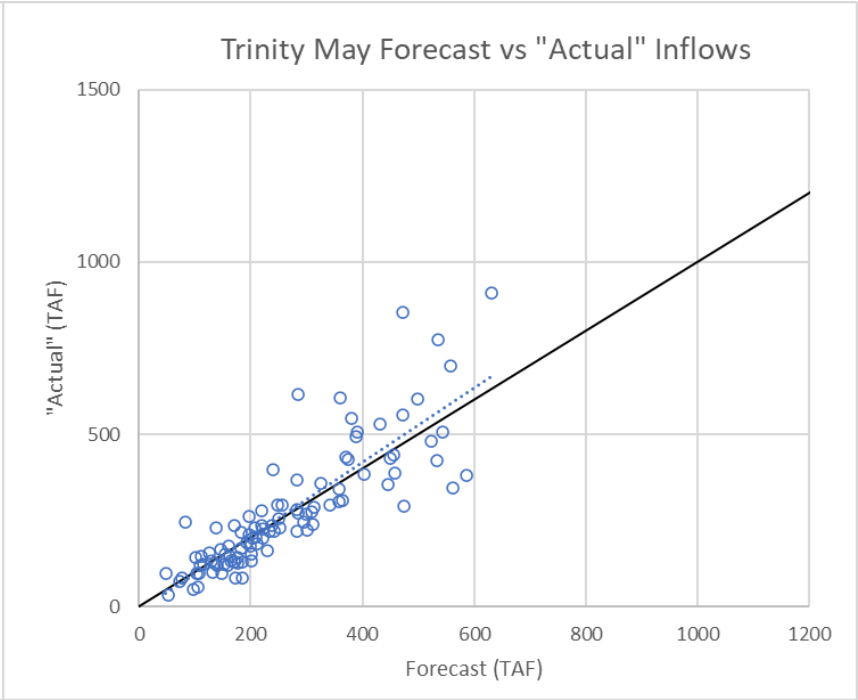
Trinity 2022MED

- Median inflow forecasts

	Nominal Exc	Exceedance
Mar	50%	43.0%
Apr	50%	46.0%
May	50%	41.0%

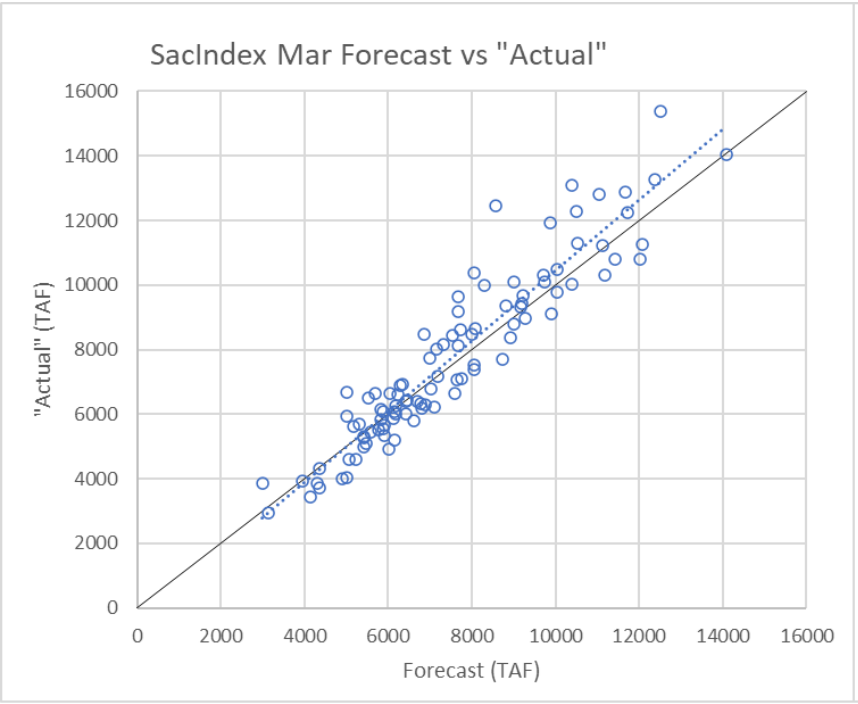


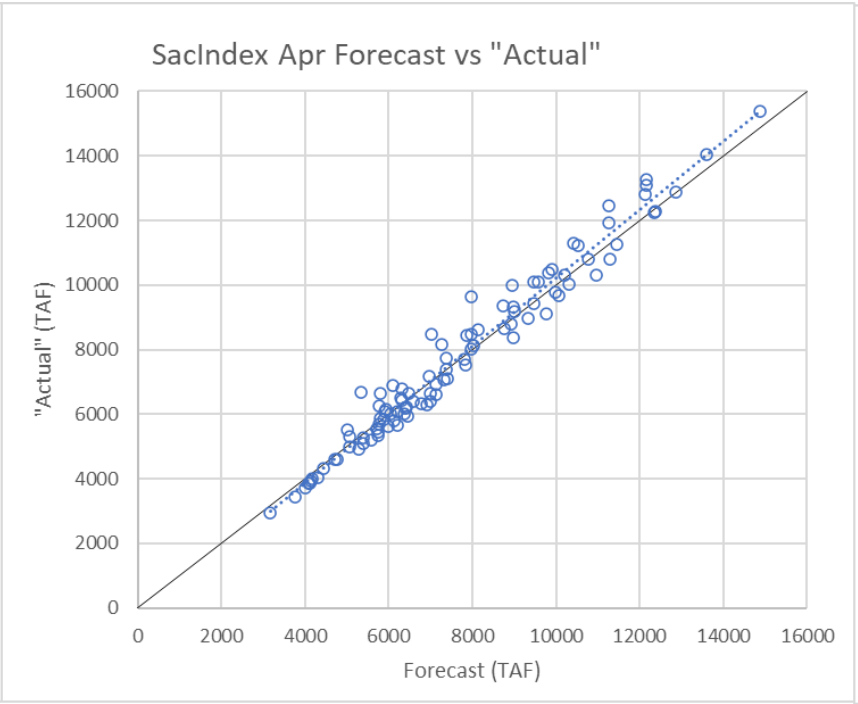


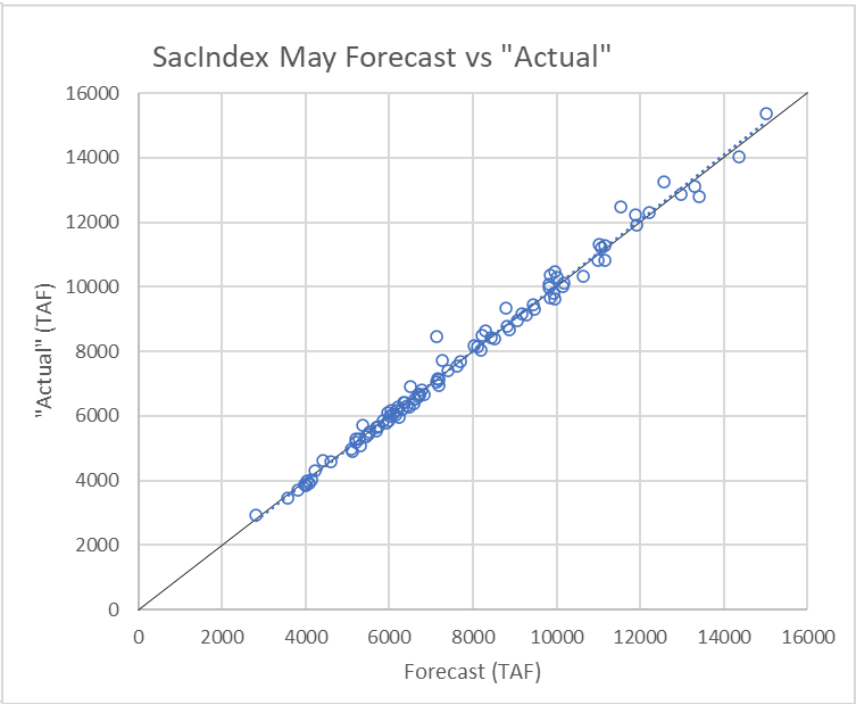


Sac River Index 2022MED

- Weighted flow from 4 rivers: Sac, Feather, Yuba, American.
- Determines water year type (WYT) on Sac River
  - Reservoir and Delta operations







Historical DLL and B120 WYT Classification

- Compare WYTs for 1970-2021
  - Actual
    - Historical data reconstructed WYT
  - Forecasts
    - B120
    - Hydroforecast DLL (MSO)
- Similar distribution of mismatched years.
- Decreasing uncertainty with time.
- One more mismatched year from Feb-Apr, less mismatched years by May.

		Sacramento Valley, WY 1970-2021		
Forecast Date	Source	Number of years that computed WYT differ from the Reconstructed	Number of years that computed WYT is drier than the Reconstructed	Number of years that computed WYT is wetter than the Reconstructed
1-Feb	B120	22	12	10
	MSO	23	12	11
1-Mar	B120	22	12	10
	MSO	23	11	12
1-Apr	B120	12	4	8
	MSO	13	4	9
1-May	B120	7	1	6
	MSO	3	1	2

Equal or less mismatch years

Conclusions

- Hydroforecast DLL forecasts monthly inflows at major river locations for forecast-based allocations and operations in CalSim3
- Provides reasonable forecasts for historical and alternative hydrology such as Climate Change scenarios.
- Assuming the watershed will behave the same as historical condition under future climate change condition.

Contacts and Questions

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