CALIFORNIA DEPARTMENT OF WATER RESOURCES

A New Normal: Adjusted Historical Hydrology

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Background

- Historical hydrological datasets (WY1921~2015) were used as the baseline hydrology to represent the current hydroclimate conditions in previous Delivery Capability Report (DCR) .

- Adjusted Historical Hydrology (AHH) was developed under the guidance of DWR's Historical Data Adjustment Workgroup which analyzed unimpaired flow timeseries in the last 100 years (WY1921~2021) using various statistics, developed metrics and plotting tools for screening different methods, and evaluated several adjusting methods.

- AHH is becoming a new normal representing the current hydroclimate conditions in CalSim 3 studies. It has been used as the baseline hydrology in 2023 DCR studies.

Background

Why are adjustments to historical hydrologic conditions needed for CalSim 3 modeling?

- More extreme climate conditions as seen that dry years are getting drier and wet years are getting wetter as shown in historical precipitation due to climate change and land use change
- There are shifts in historical hydrologic conditions due to climate changes that leads to changes in watershed runoff characteristics (Runoff Curves)
- AHH is more representative of current climate conditions than the unadjusted historical hydrology

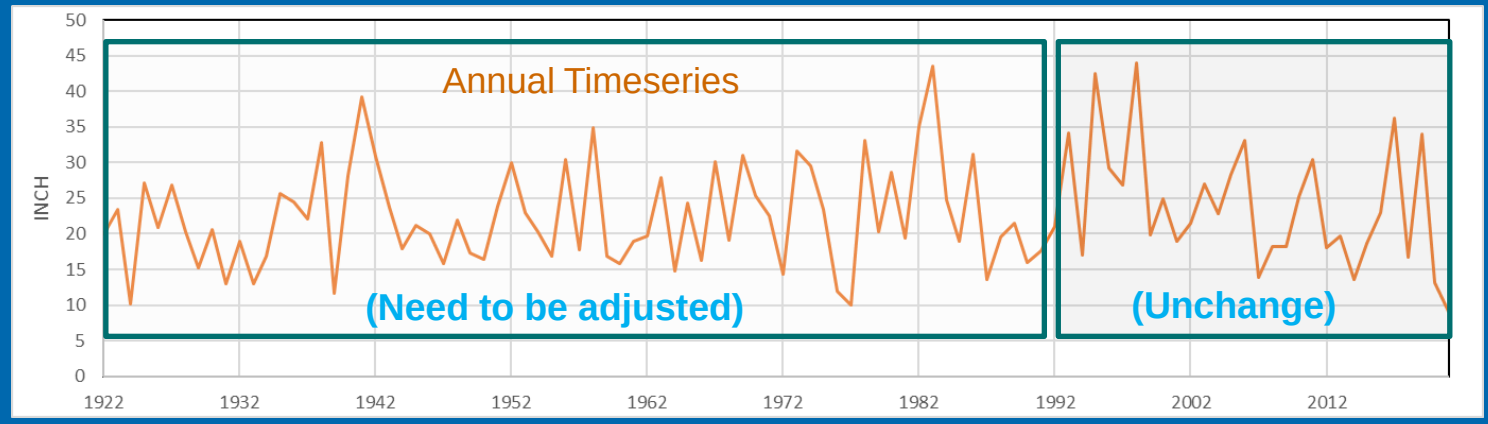
Background

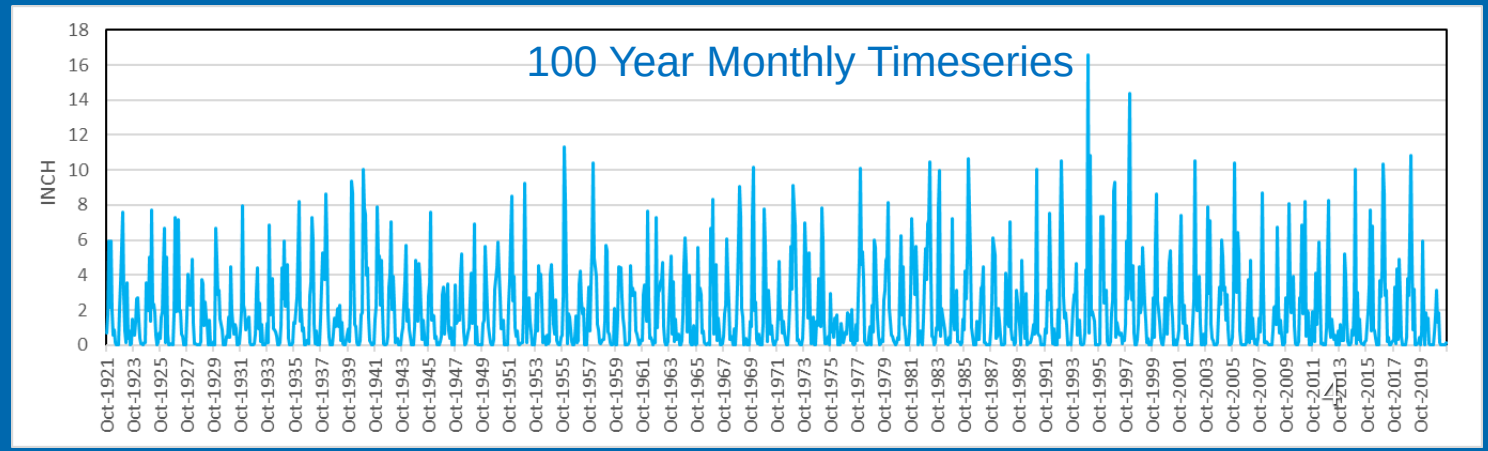
How to adjust historical hydrologic conditions?

- Adjust Historical precipitation int the early historical 70-year period using the standard deviation of the annual precipitation in the current 30-year climate window.
- Adjust rim inflow based on the annual runoff curve and monthly stream flow distribution in the current climate window.
- Adjust other hydrological input in the valley floor by feeding the adjusted historical precipitation into the 4 CalSim3's Valley Floor Models, i.e., CalSimHydro, CalSimHydroEE, Small Watershed, and Delta Channel Depletion.

- Historical Climate Window
- (WY1922-1991)

- Current Climate Window
- (WY1992-2021)





Adjust Historical Hydrology

AHH provides CalSim 3 with 100-year monthly hydrologic input timeseries:

1) adjusted historical precipitation,

2) adjusted historical rim inflow, and

3) valley floor hydrological datasets derived using adjusted historical precipitation
   - Surface runoff from rainfall
   - Applied water (required irrigation)
   - Irrigation return flow
   - Deep percolation to groundwater aquifer

Main Equations for Adjusting Historical Hydrology

Annual Precipitation Adjusting Equation

$$P_{wy}^{Adj} = \boldsymbol{\mu}_{his} + \frac{\boldsymbol{\sigma}_{ref}}{\boldsymbol{\sigma}_{his}} \cdot \left[\boldsymbol{P}_{wy} - \boldsymbol{\mu}_{his}\right]$$

Annual Flow Adjusting Equation

$$F_{wy}^{adj} = F_{wy} + RCV\left[P_{wy}^{adj}\right] - RCV\left[P_{wy}\right]$$

Monthly Flow Adjusting Equation

$$F_{wy,m}^{adj}(y,m) = \omega_{wy,m}^{adj}(y,m) \cdot F_{wy}^{adj}(y)$$

$\boldsymbol{\mu}_{his}$ – Mean Annual Precipitation [WY1922 – 1991]

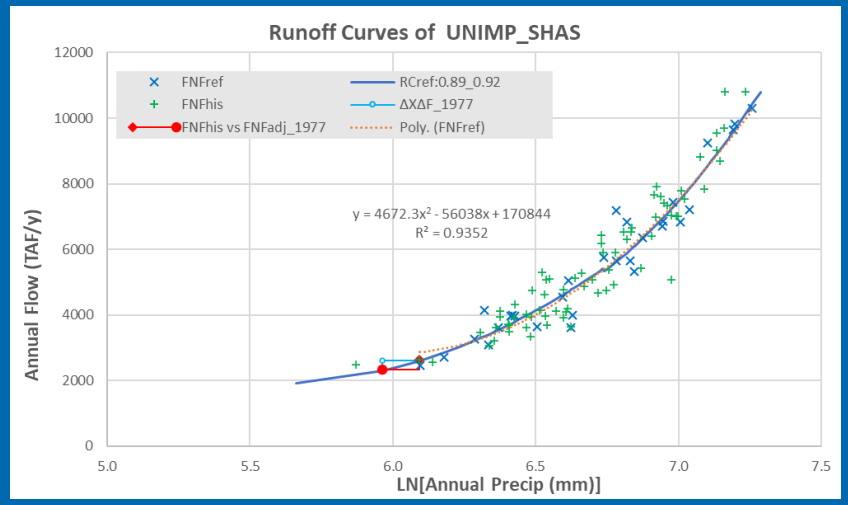
$\boldsymbol{\sigma}_{his}$ – STDev Annual Precipitation [WY1922 – 1991]

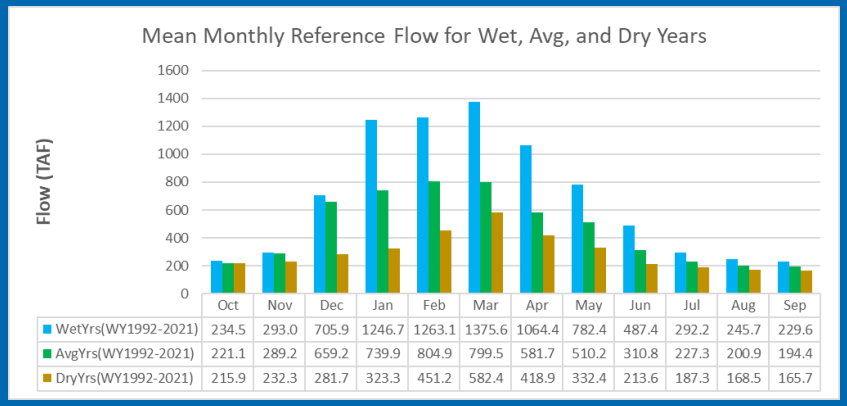
$\boldsymbol{\sigma}_{ref}$ – STDev Annual Precipitation [WY1992 – 2021]

RCV – Reference Runoff Curve Function

$$RCV = a_X^{ref} + b_X^{ref} \cdot \ln\left(P_{wy}(y)\right) + c_X^{ref} \cdot \left[\ln\left(P_{wy}(y)\right)\right]^2$$

$\omega_{wy,m}^{adj}(y,m)$ - Monthly flow pattern parameters





	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
WetYrs(WY1992-2021)	234.5	293.0	705.9	1246.7	1263.1	1375.6	1064.4	782.4	487.4	292.2	245.7	229.6
AvgYrs(WY1992-2021)	221.1	289.2	659.2	739.9	804.9	799.5	581.7	510.2	310.8	227.3	200.9	194.4
DryYrs(WY1992-2021)	215.9	232.3	281.7	323.3	451.2	582.4	418.9	332.4	213.6	187.3	168.5	165.7

Comparison of AHH and Historical Hydrology

- Hydrologic Conditions in DCR 2023
  - **Historical Hydrology**
    - **Previous DCR Studies**
  - **Adjusted Historical Hydrology**
    - **DCR 2023 Baseline**

} **Comparison of AHH and Historical Hydrology**

  - Future Climate Scenarios
    - Risk-Informed Scenarios with Levels of Concern

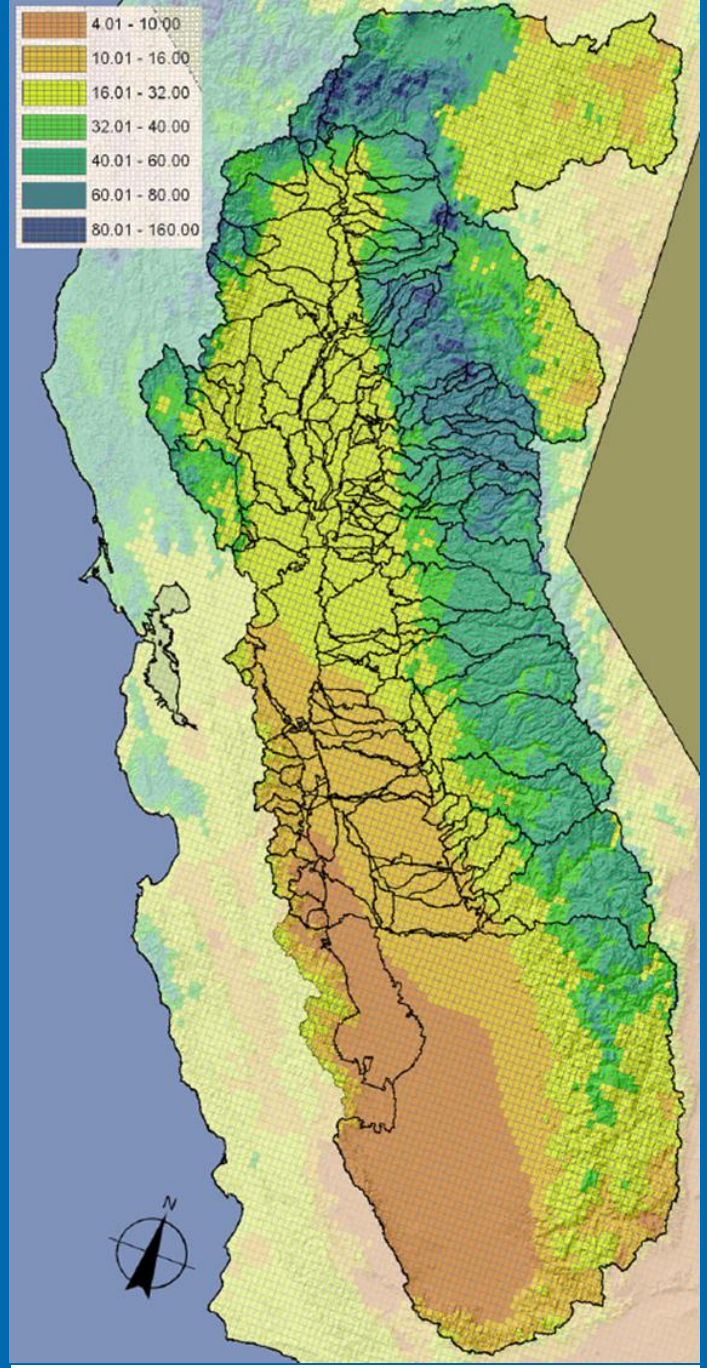
Comparison of AHH and Historical Hydrology

– Sacramento vs San Joaquin, and Historical vs Adjusted Historical

1. Rim Watersheds
   - Precipitation
   - Rim Inflow

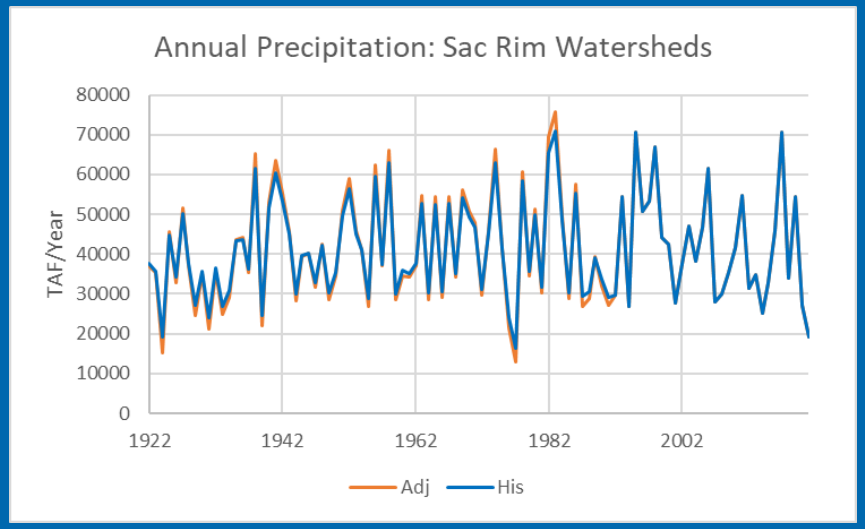
2. Valley Floor WBAs
   - Precipitation
   - Surface Runoff
   - Ag & Refuge Applied Water
   - Return Flow

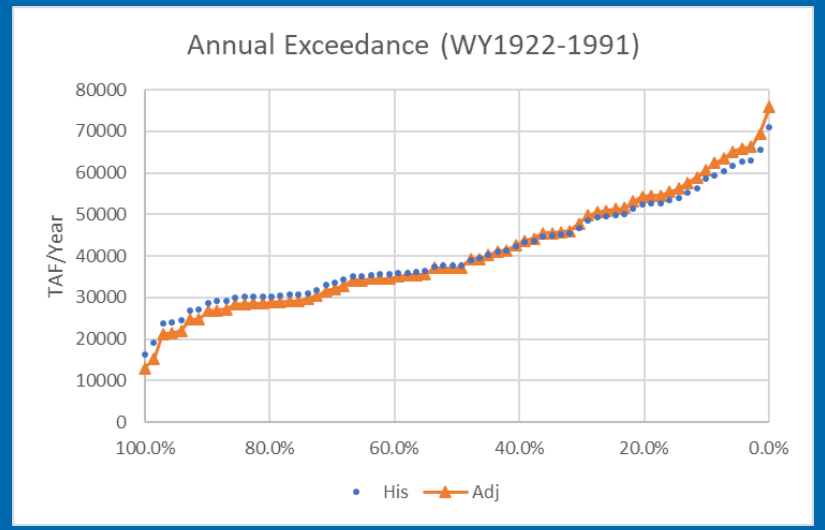
3. Valley Floor Groundwater
   - Stream Gain from Groundwater Aquifer

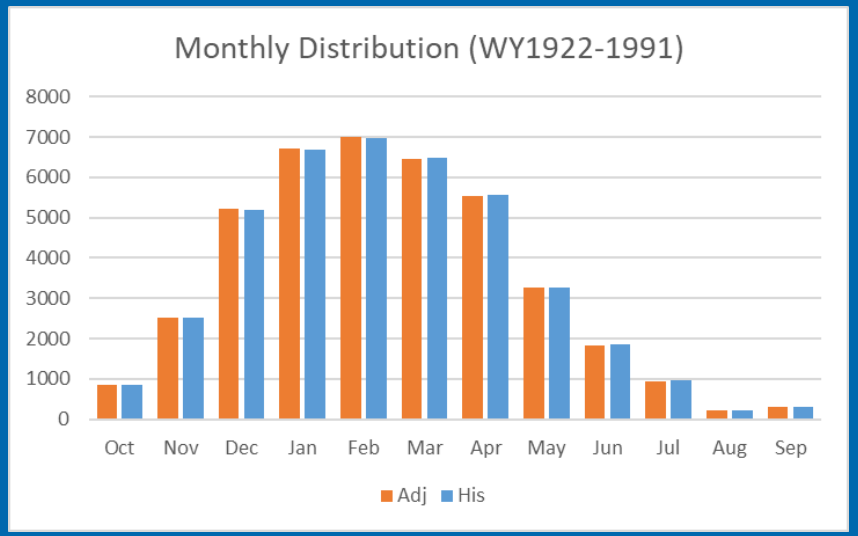


Mean Annual PRISM Prec (In)

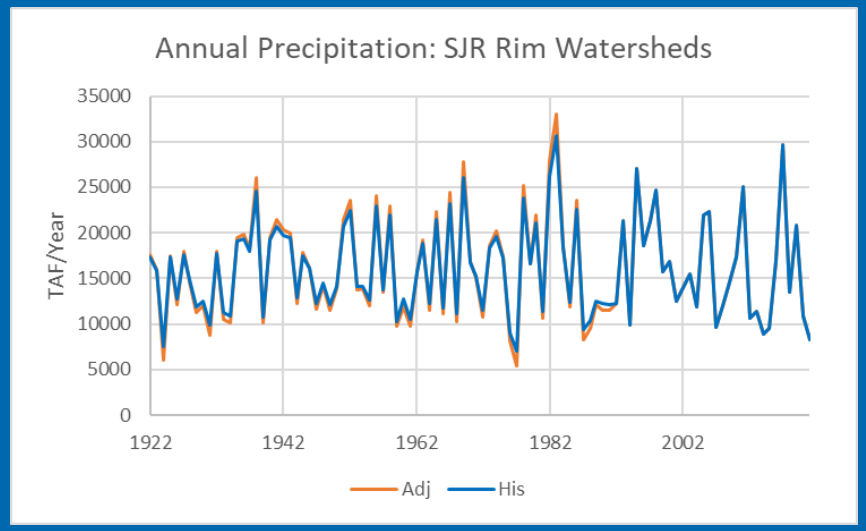
Precipitation – Sacramento Rim Watersheds

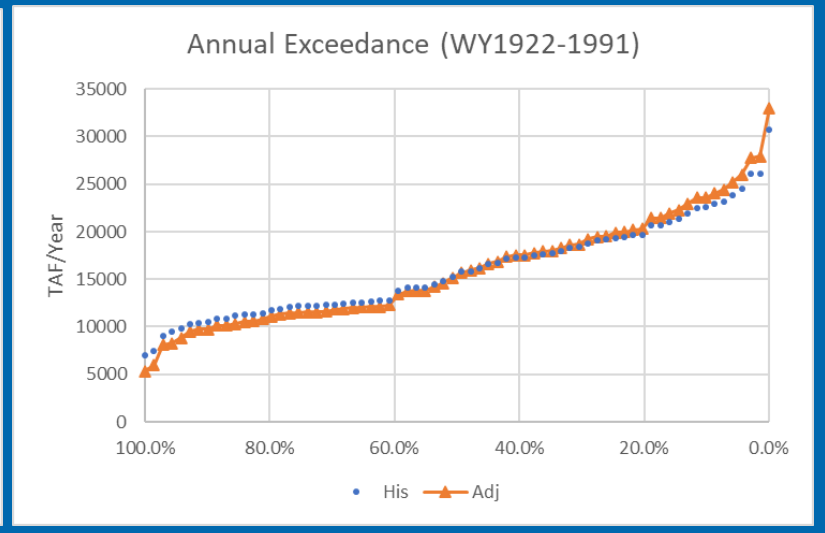


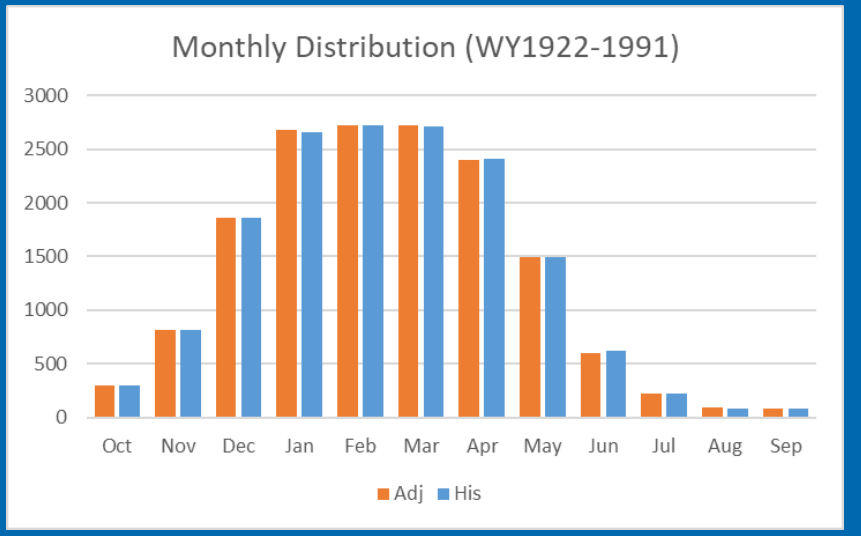




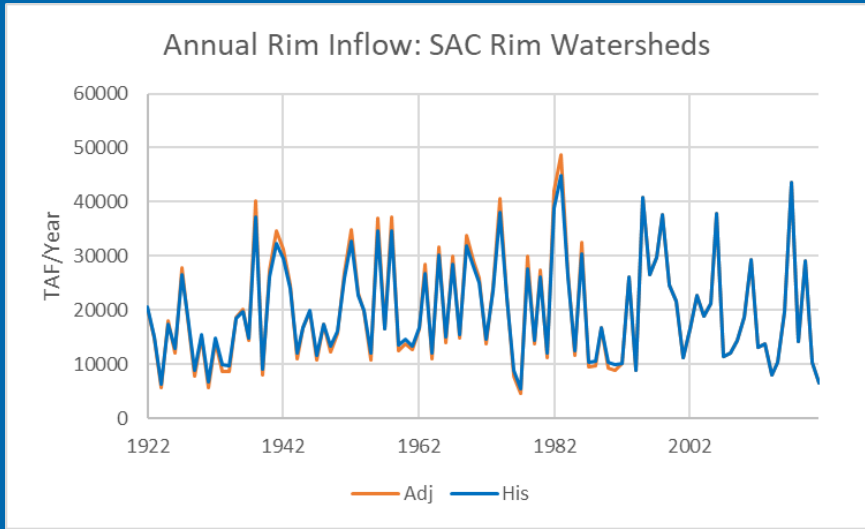
Precipitation – San Joaquin Rim Watersheds

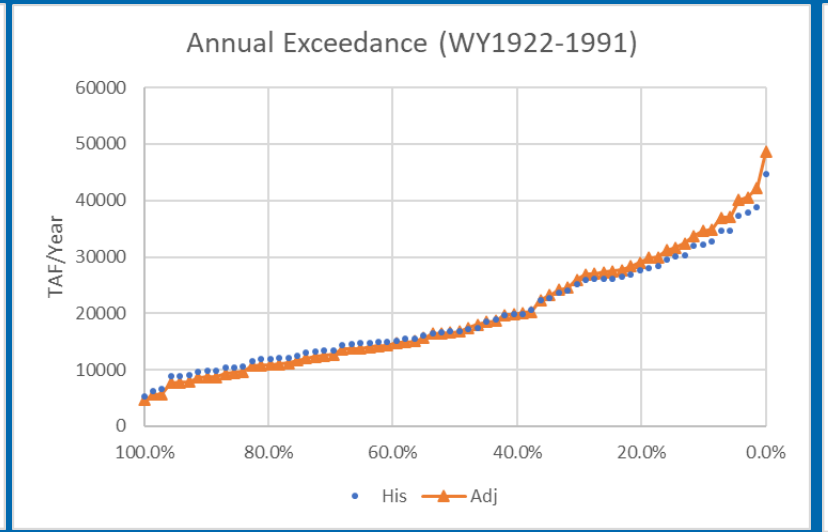


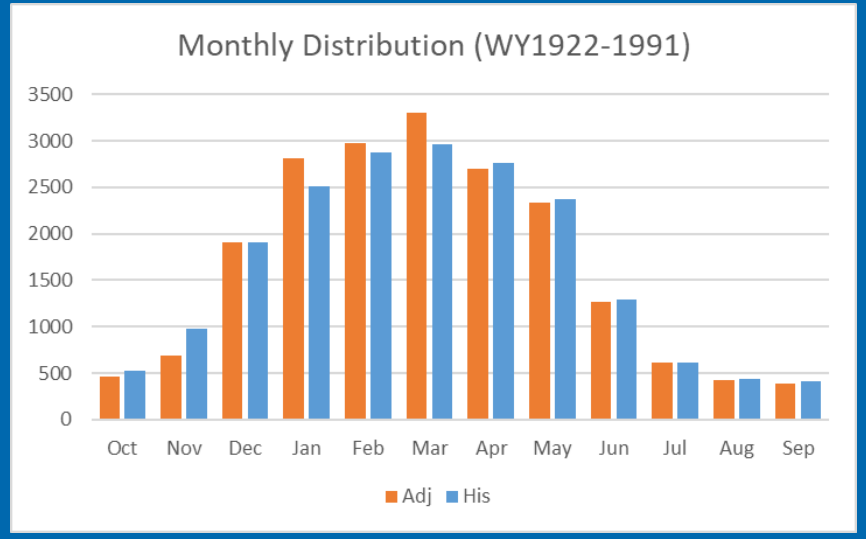




Rim Inflow – Sacramento Rim Watersheds







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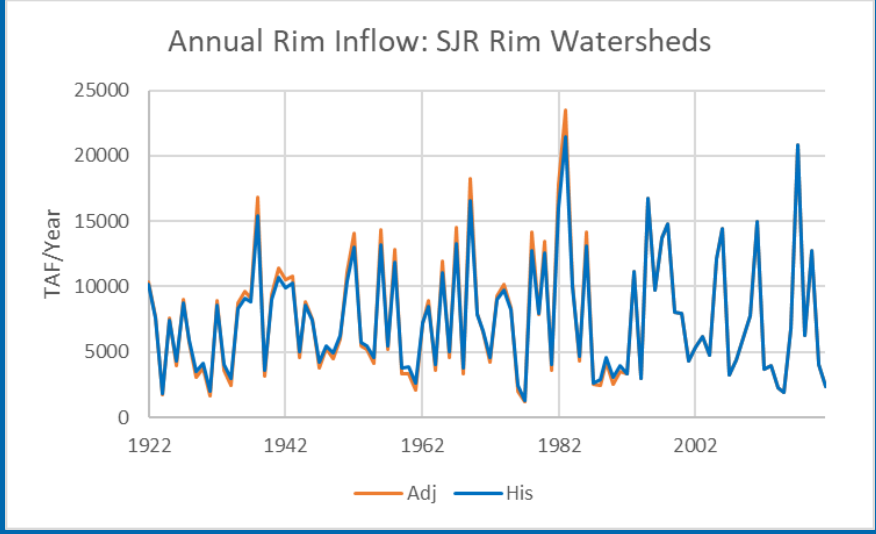
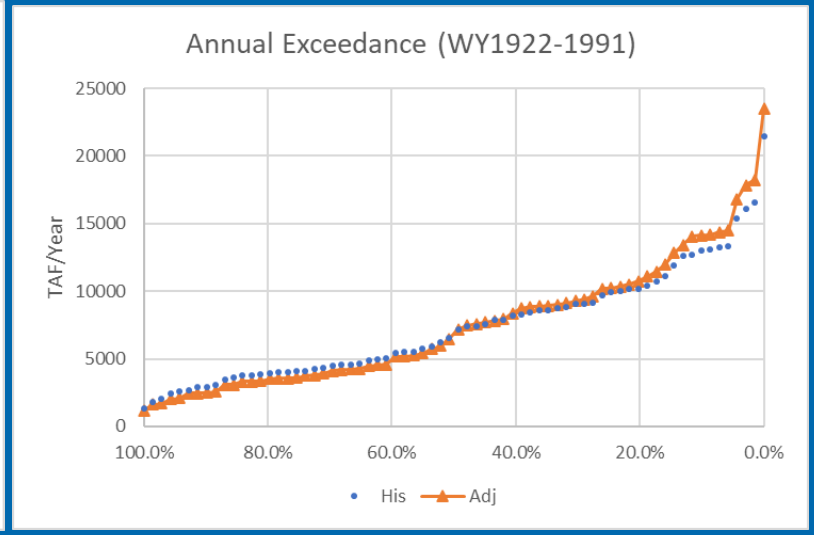
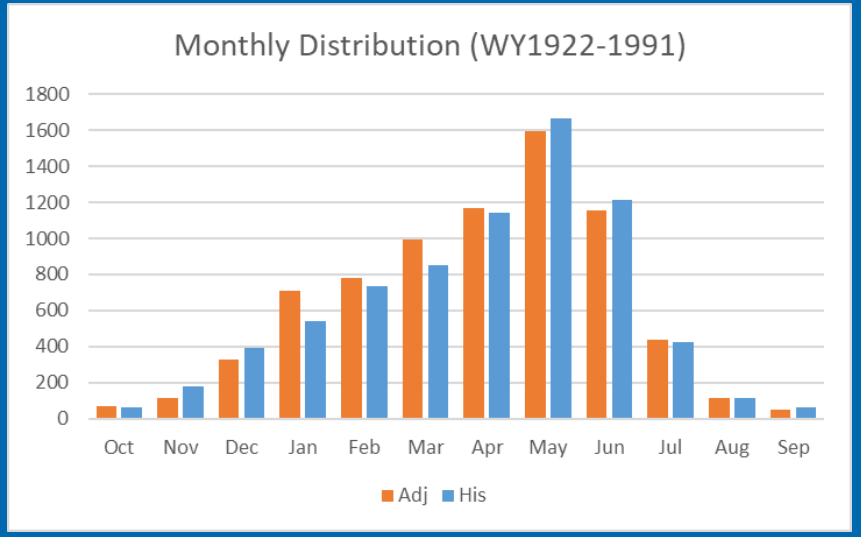
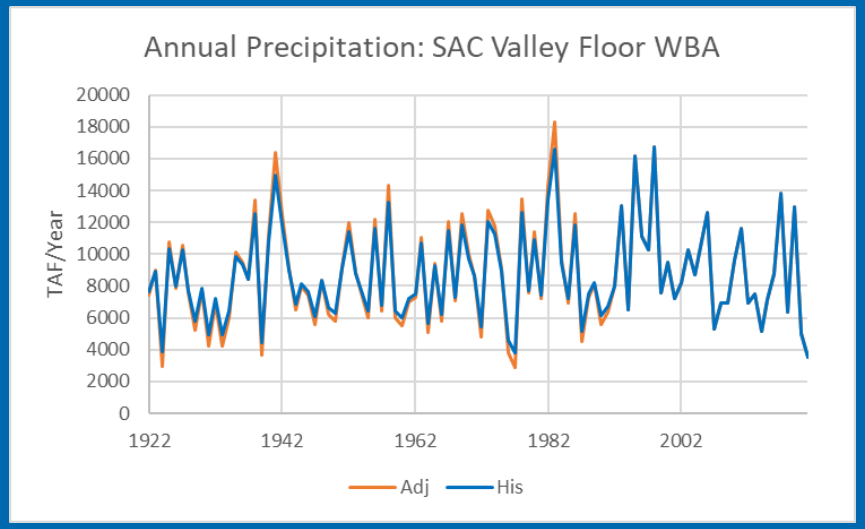
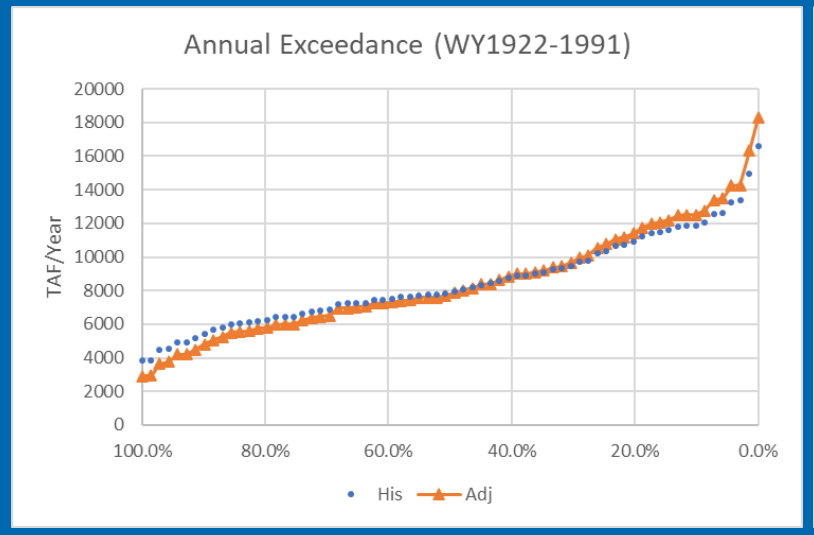


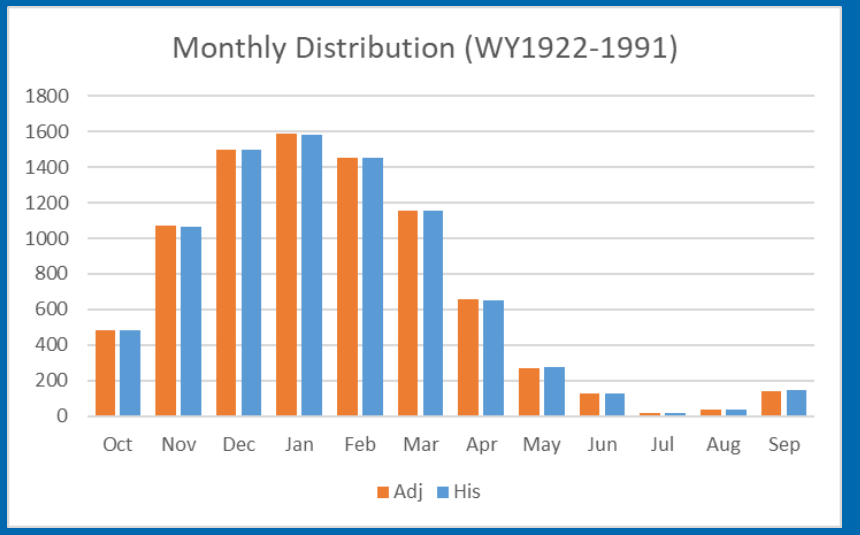




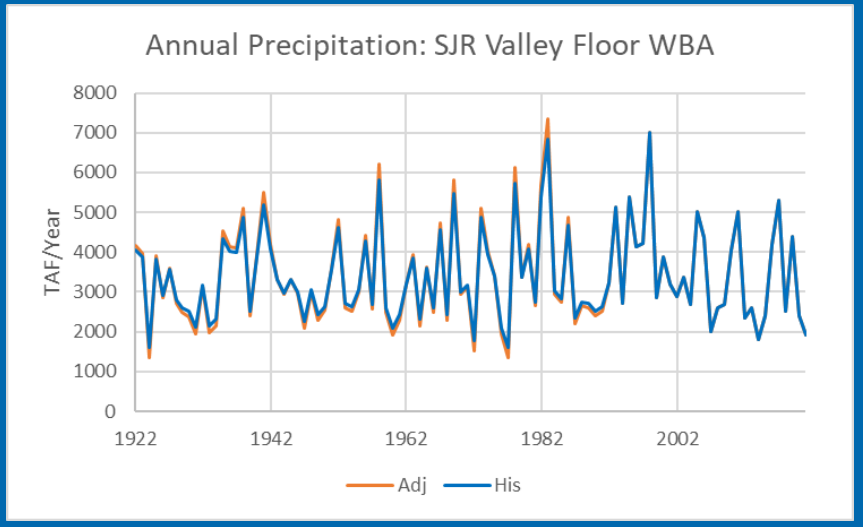
Precipitation – Sacramento Valley Floor WBAs

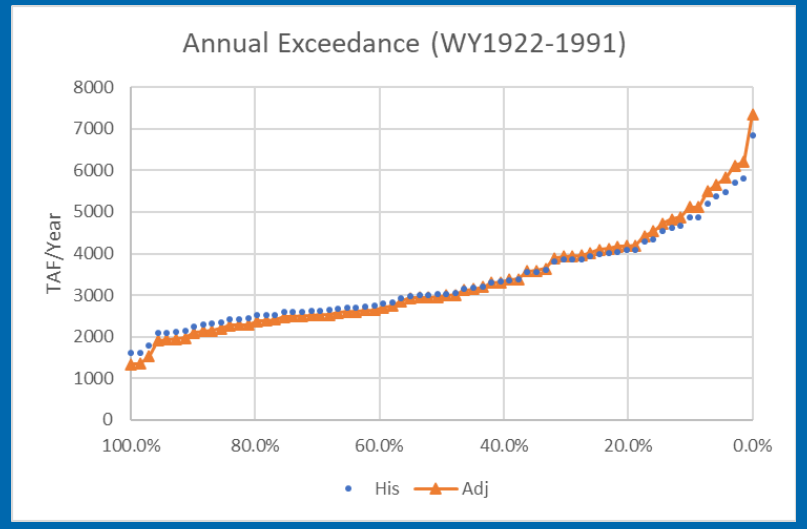


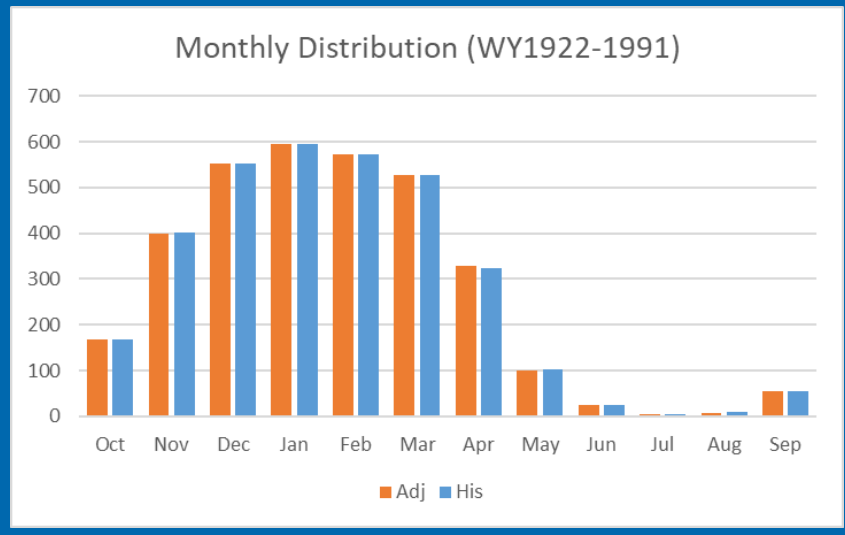




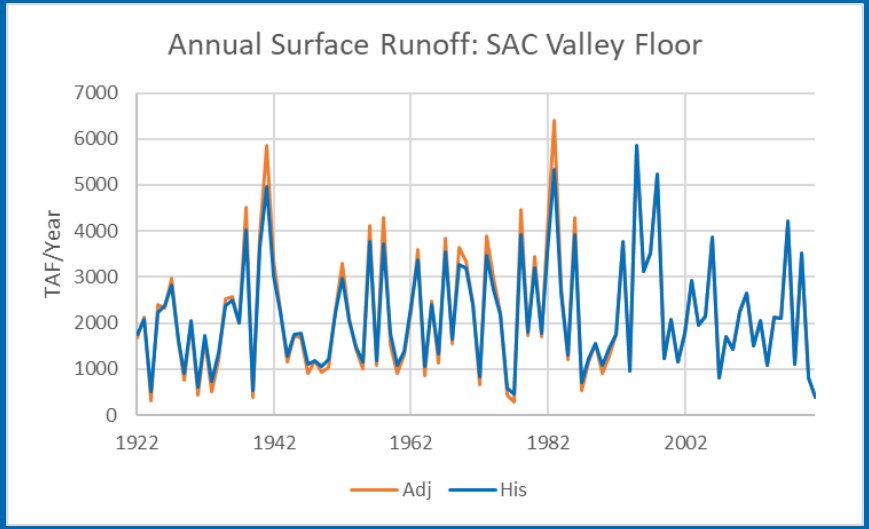
Precipitation – San Joaquin Valley Floor WBAs

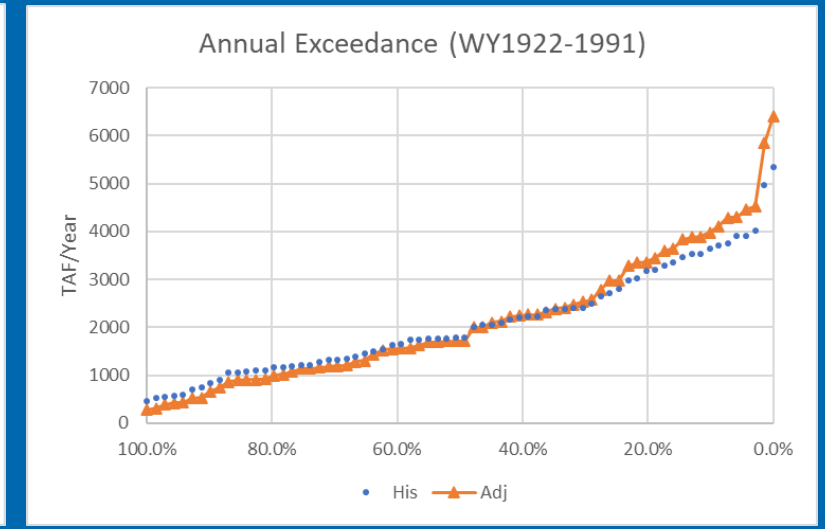


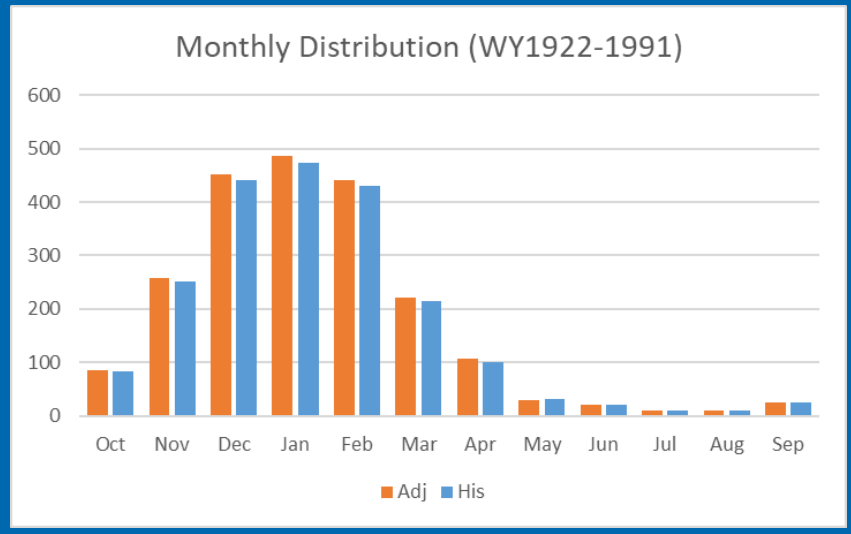




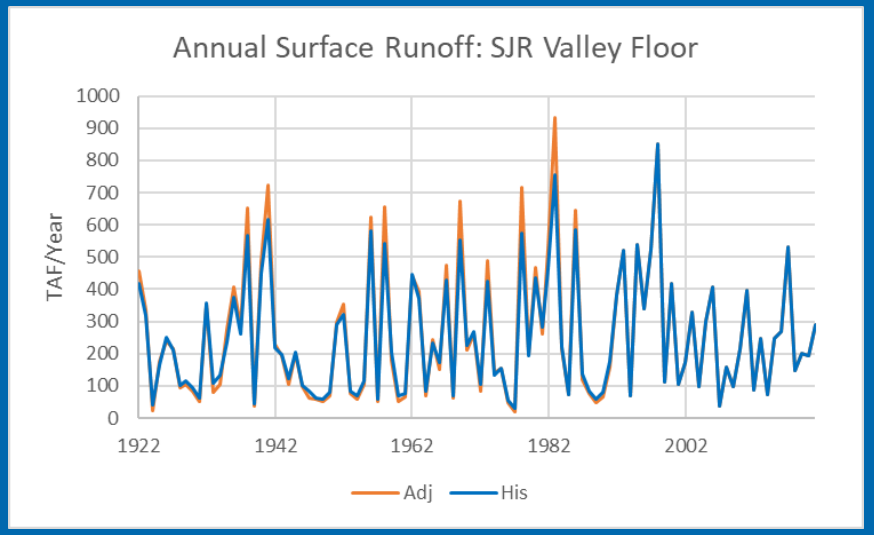
Surface Runoff – Sacramento Valley Floor WBAs

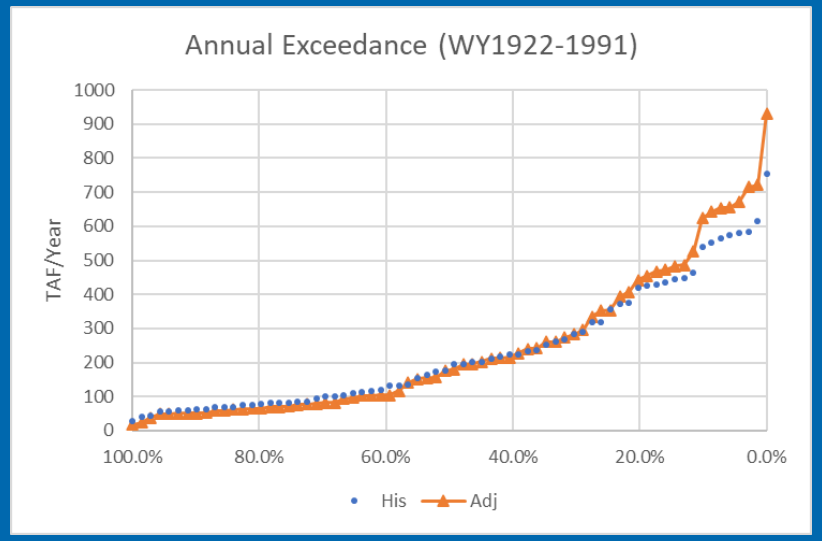


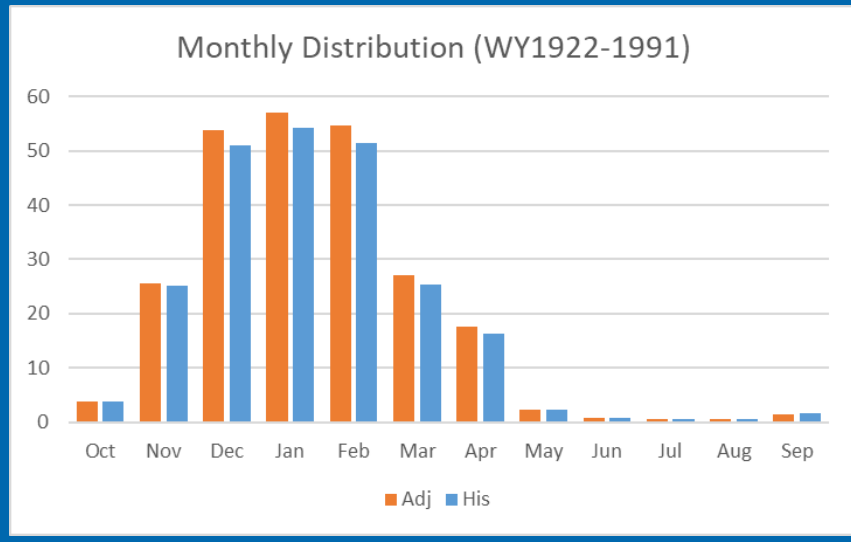




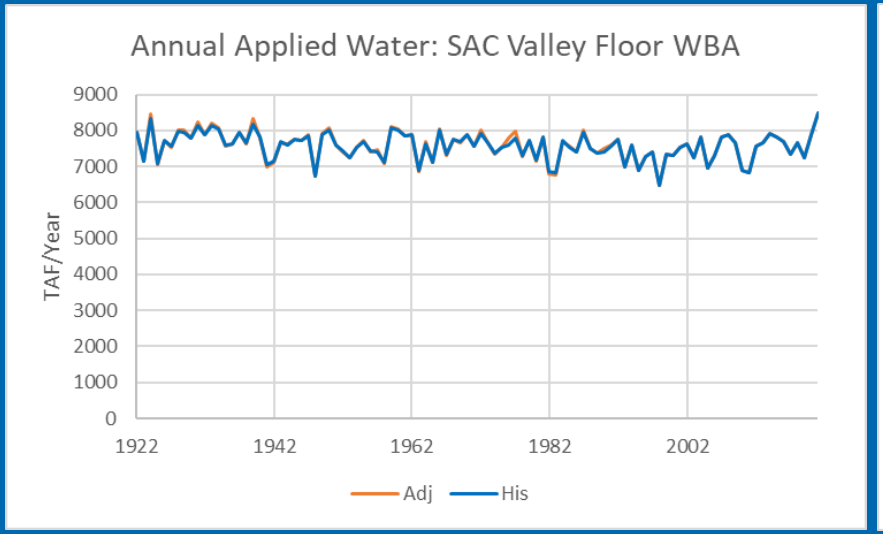
Surface Runoff – San Joaquin Valley Floor WBAs

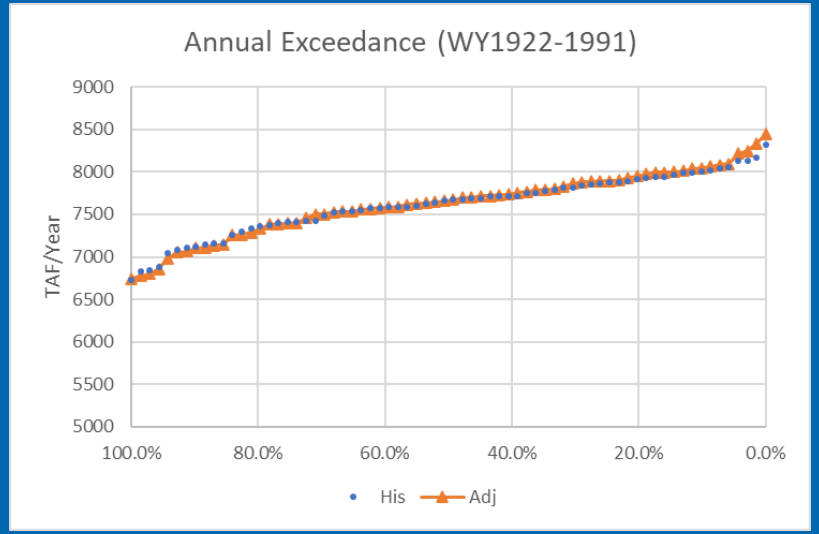


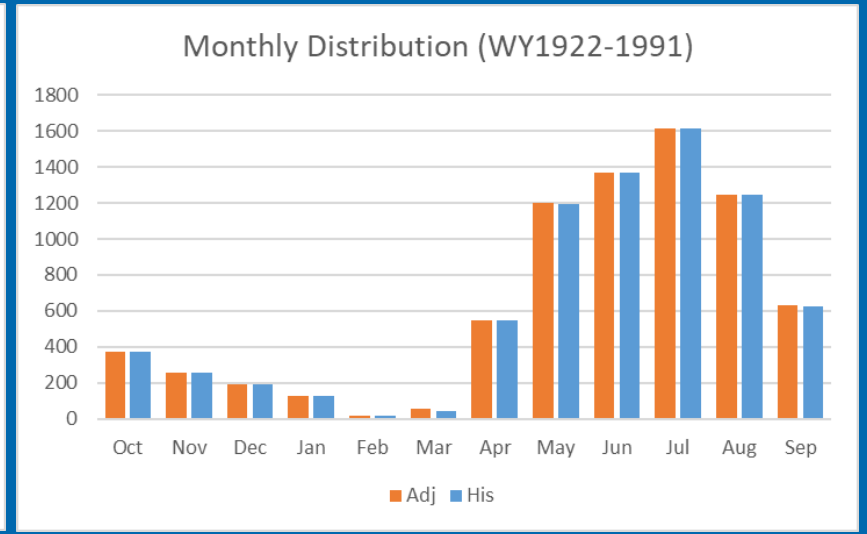




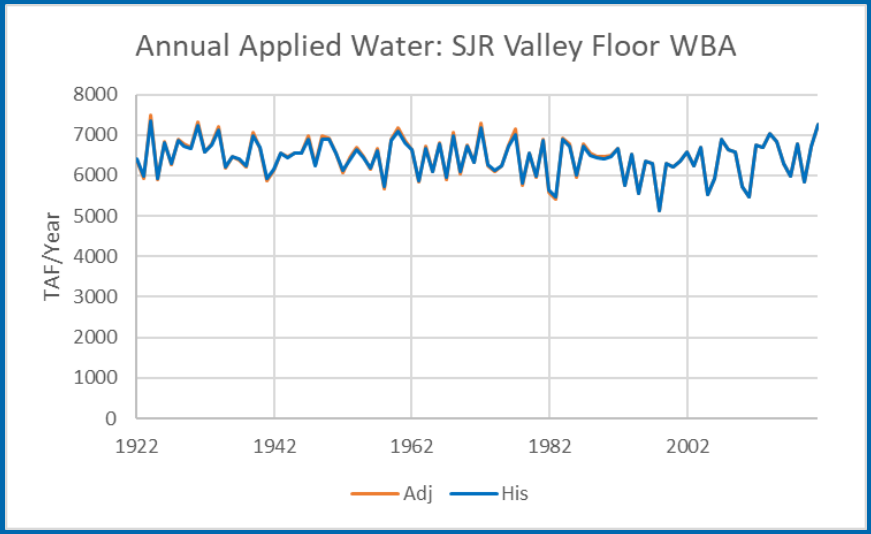
Agriculture and Refuge Applied Water – Sacramento Valley

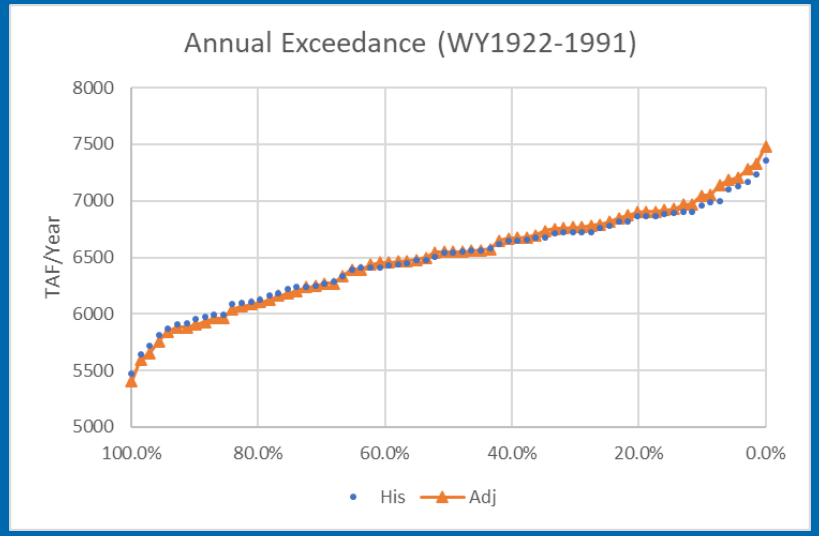


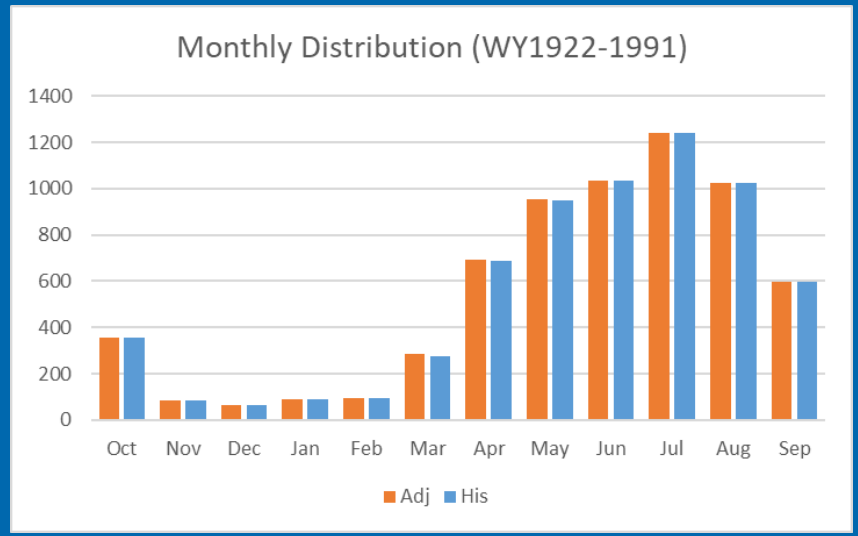




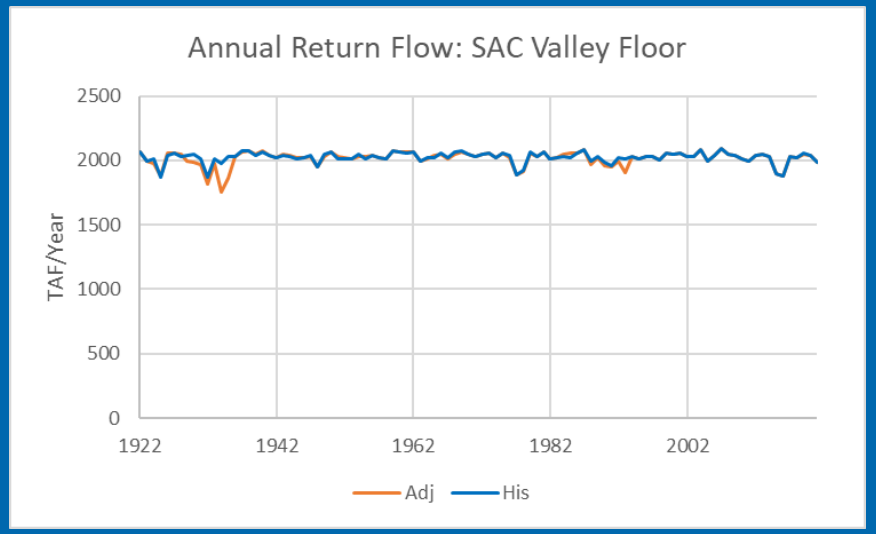
Agriculture and Refuge Applied Water – San Joaquin Valley

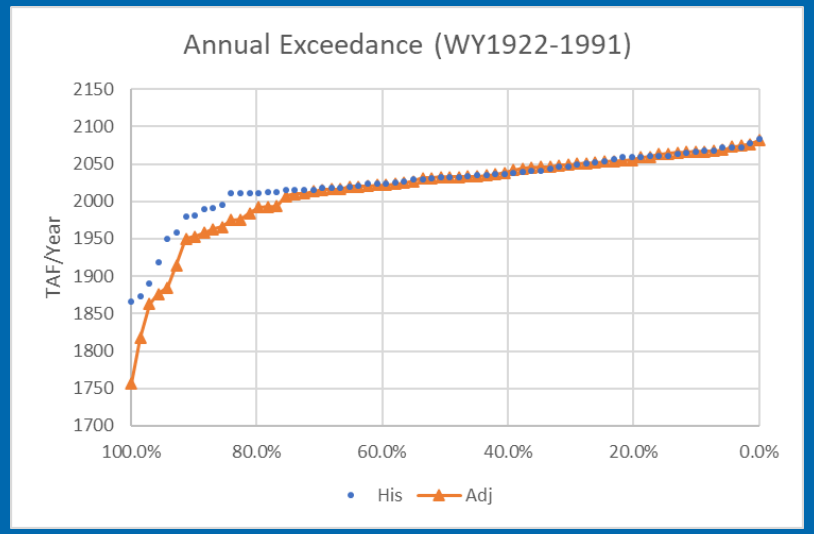


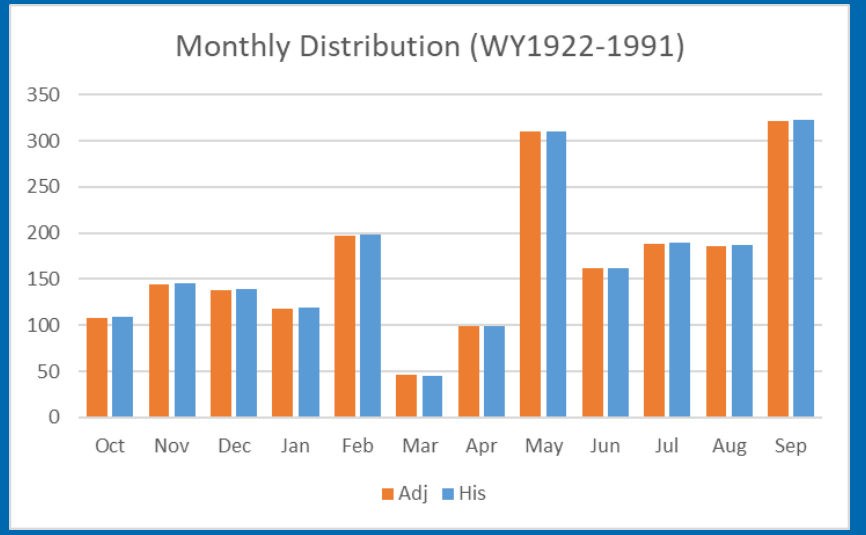




➢Return Flow of Applied Water and Urban Water – Sacramento Valley







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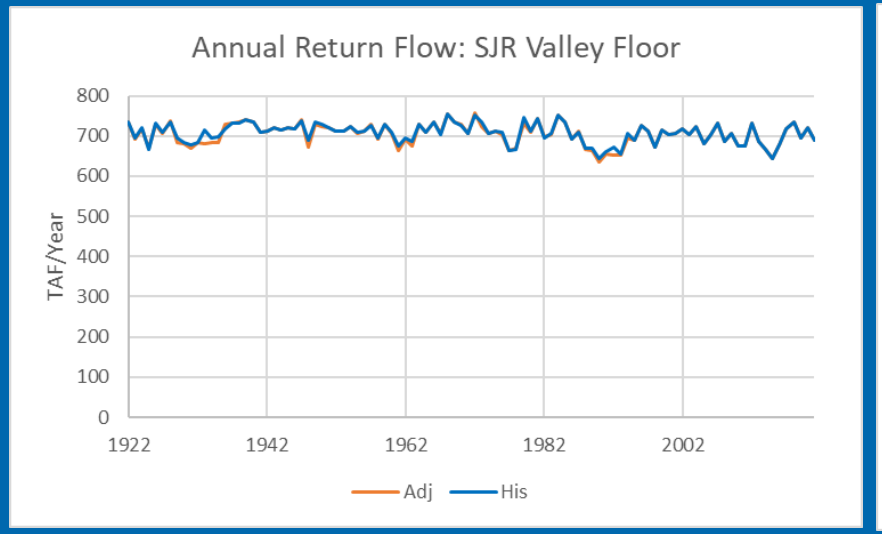
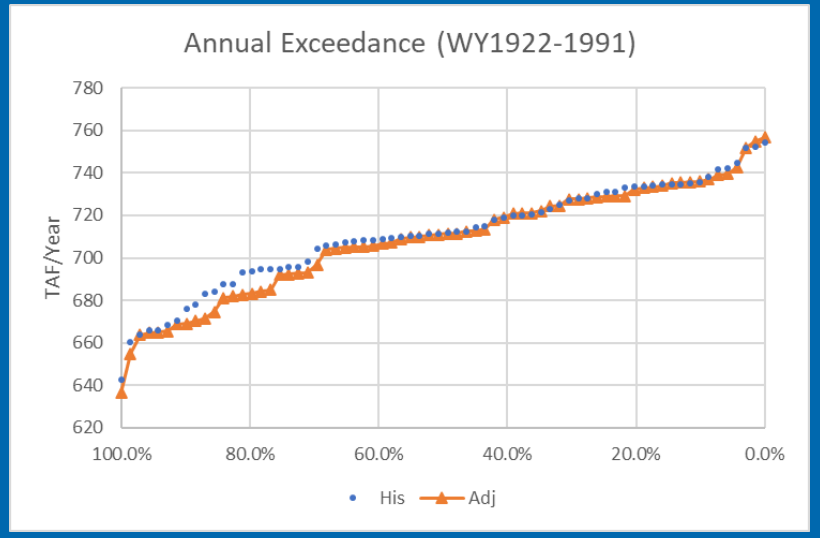
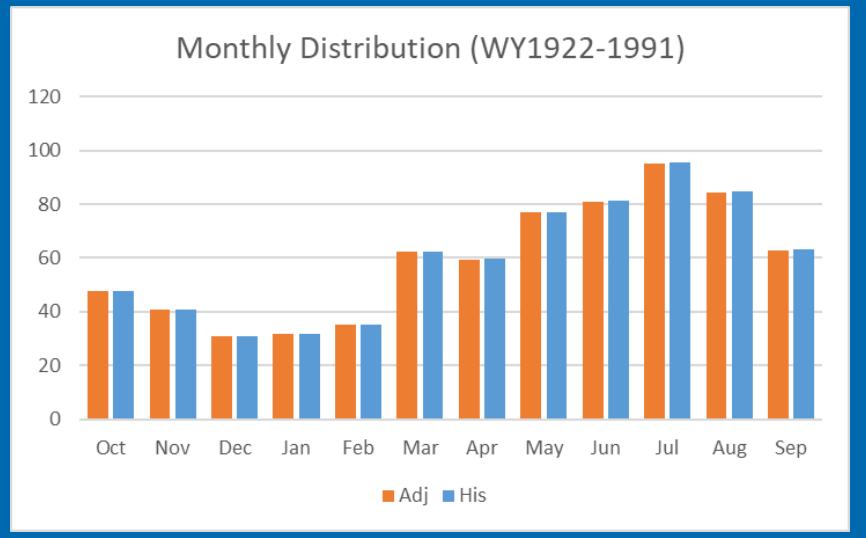
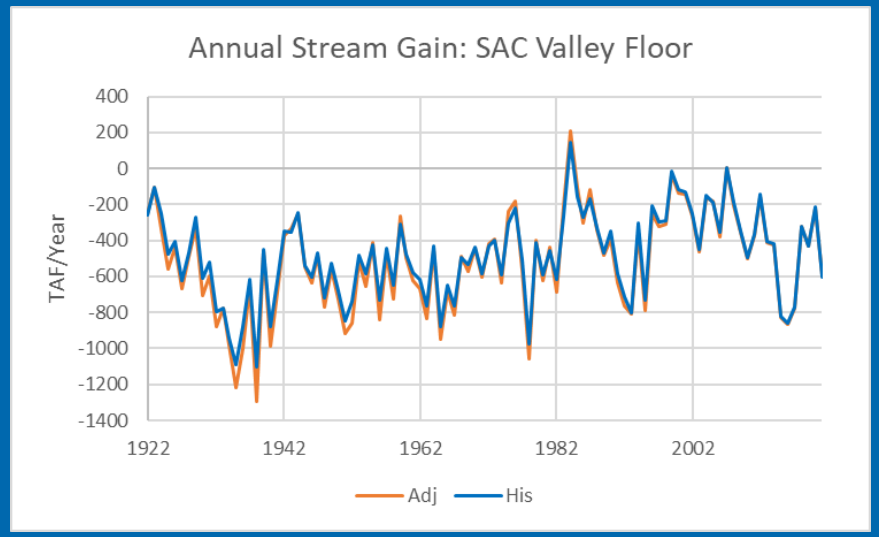
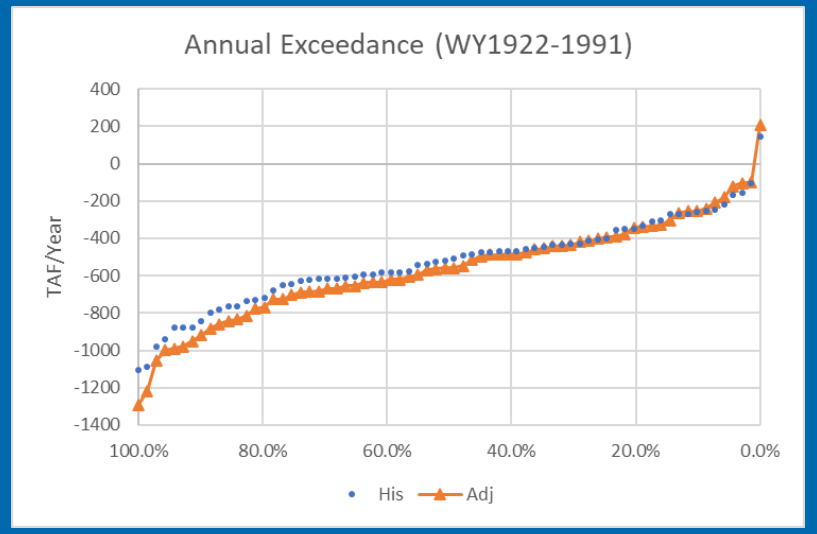


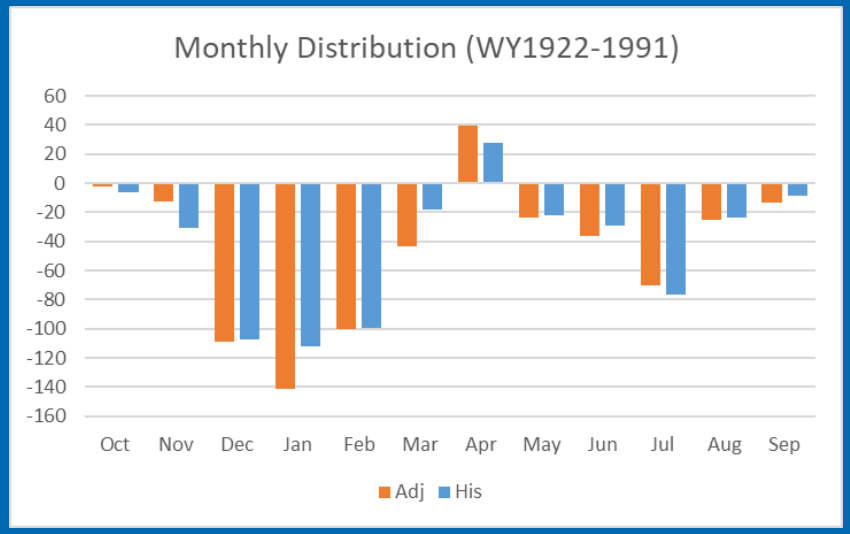




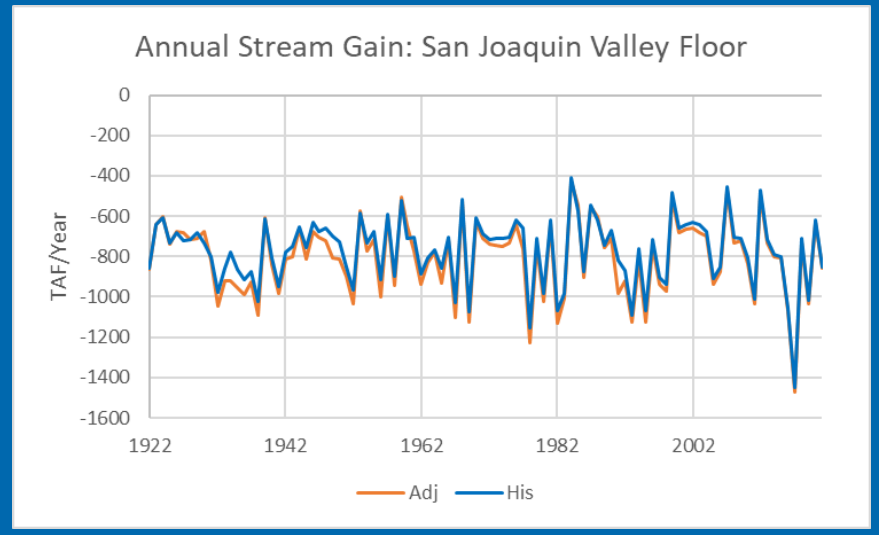
➢Stream Gain from Groundwater Aquifer – Sacramento Valley

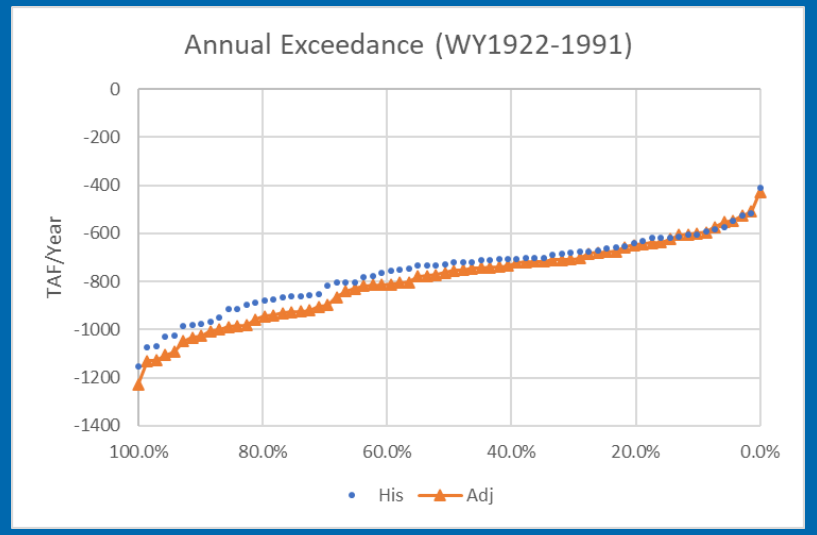


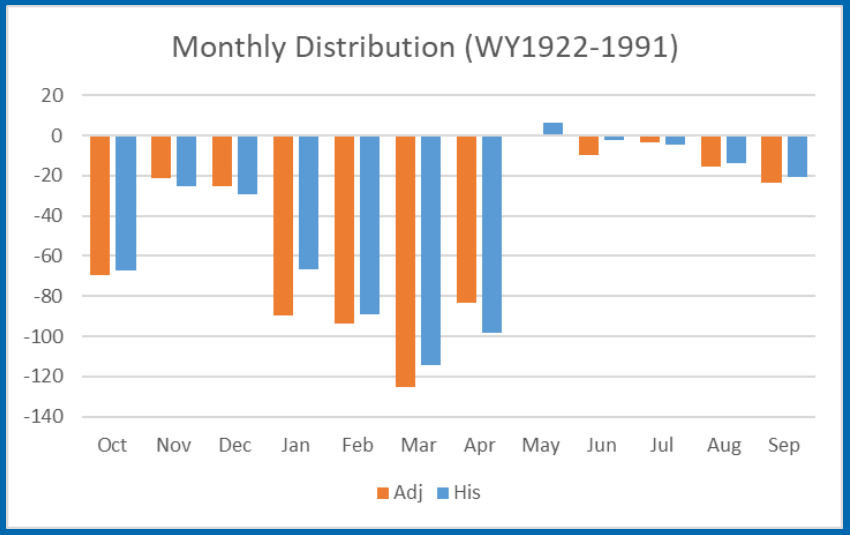




➢Stream Gain from Groundwater Aquifer – San Joaquin Valley







➢ Mean Annual Inflow to Stream

Mean Annual Flow WY1922-1991 (TAF/Year)	Sacramento Valley				San Joaquin Valley			
	His	Adj	Adj-His	% Change	His	Adj	Adj-His	% Change
Rim Inflow	21035	21291	256	1.2%	7387	7525	138	1.9%
Valley Floor Surface Runoff	2092	2147	55	2.6%	193	203	10	5.2%
Valley Floor Return Flow	2025	2015	-10	-0.5%	711	708	-3	-0.4%
Stream Gain/loss	-506	-537	-31	-6.1%	-525	-560	-35	-6.7%
Net Inflow to Stream	24646	24916	270	1.1%	7766	7876	110	1.4%

Summary

- Monthly distributions of the adjusted rim inflows do reflect the fact that runoff occurs earlier because of changes in snowmelt and evapotranspiration processes for different type water years and different type watersheds

- Mean annual rim inflow and valley floor rainfall runoff increased in AHH even the mean annual precipitation and monthly precipitation distribution for both historical hydrology and AHH are the same.

- The adjusting method has made the adjusted rim inflows and valley runoff wetter in wet years drier in dry years

Question?