Supplement

S1 Data

Table S1: Full-natural flow gauges

Basin	Gauge name	CDEC gauge code
Shasta	Sacramento River above Bend Bridge	SBB
Feather	Feather River at Oroville	FTO
Yuba	Yuba River near Smartville	YRS
American	American River at Folsom	AMF
Cosumnes	Cosumnes River at Michigan Bar	CSN
Mokelumne	Mokelumne - Mokelumne Hill	MKM
Stanislaus	Stanislaus River - Goodwin	SNS
Tuolumne	Tuolumne River - La Grange Dam	TLG
Merced	Merced River near Merced Falls	MRC
San Joaquin	San Joaquin River below Friant	SJF
Kings	Kings River - Pine Flat Dam	KGF
Kaweah	Kaweah River - Terminus Dam	KWT
Kern	Kern River - below Isabella	KRI
Tule	Success Dam	SCC

S2 *abcd* model results

The *abcd* model (Thomas, 1981) can be understood under a generalized proportionality hypothesis framework (Wang and Tang, 2014). The primary equation assumes PET or "evaporation opportunity", Y, for each time step as a function of available water and two parameters, a and b. The former ranges from zero to one and can be understood physically as the tendency for runoff to occur in the basin before the soil is saturated. The latter is the maximum evaporation opportunity, measured in depth. Soil storage in the model is calculated under the assumption that actual ET from the soil occurs in proportion to PET, Y. The model goes on to separate direct runoff from groundwater recharge based on parameters c and d, allowing total streamflow and baseflow to be calculated as well. However, as the primary goal of using the *abcd* model here was calculating change in soil storage, we did not use parameters c or d. For more details on the *abcd* model and its use in conjunction with the Budyko model, see Du et al. (2016).

A basic sensitivity test was performed for the initial conditions for soil and groundwater storage, which were tested one at a time. The value and direction of shift in ω are robust to initial values ranging between 5 and 500 mm, to reflect the order of magnitude of maximum dry-season storage water draw down that has been reported in the Sierra (Roche et al., 2020). Only in one basin, the San Joaquin, did ω show a shift in the opposite direction for initial soil storage values of 100 and 500 mm.

Table S2: *abcd* model final calibrated parameters

Basin	Parameter a[a]	Parameter b, mm[b]
American	0.979	1355
Cosumnes	0.956	1450
Feather	0.944	1402
Kaweah	0.996	782
Kern	0.993	759
Kings	0.993	670
Merced	0.999	1396
Mokelumne	1.000	1076
SanJoaquin	0.983	780
Shasta	1.000	806
Stanislaus	0.985	1030
Tule	0.985	1442
Tuolumne	0.995	1122
Yuba	0.991	1450

[a]Parameter a reflects the propensity of a basin to generate runoff before the soil is saturated.
[b]Parameter b is the maximum possible evapotranspiration per time step.

Table S3: *abcd* model performance with respect to runoff

Basin	Nash-Sutcliffe Efficiency	Runoff relative error, 10^{-4} mm
Shasta	0.772	2.04
Feather	0.843	-6.88
Yuba	0.883	-0.11
American	0.870	-0.31
Cosumnes	0.871	-6.46
Mokelumne	0.902	8.96
Stanislaus	0.911	-3.89
Tuolumne	0.894	-0.27
Merced	0.725	-325.19
SanJoaquin	0.916	0.06
Kings	0.883	0.88
Kaweah	0.899	13.34
Kern	0.489	-29.18
Tule	0.749	28.86

S3 Statistical significance of water balance shifts

Table S4: Results of Kolmogorov-Smirnoff tests comparing drought and non-drought distributions

Basin	**PET/(P-ΔS) *p*-values**	**ET/(P-ΔS) *p*-values**
Shasta	8.69E-05	0.001987912
Feather	0.000456505	0.024630349
Yuba	0.001666759	0.007511255
American	0.000456505	0.00545947
Cosumnes	0.000309095	0.000309095
Mokelumne	0.000805859	0.007511255
Stanislaus	0.000207438	0.007511255
Tuolumne	0.000207438	0.00393314
Merced	0.000207438	0.000805859
San Joaquin	0.000207438	0.002808533
Kings	0.000207438	0.000805859
Kaweah	0.000805859	0.000805859
Kern	0.00393314	0.000805859
Tule	9.92E-06	4.79E-05

References

Du, C., Sun, F., Yu, J., Liu, X., and Chen, Y.: New interpretation of the role of water balance in an extended Budyko hypothesis in arid regions, Hydrology and Earth System Sciences, 20, 393–409, https://doi.org/10.5194/hess-20-393-2016, 2016.

Roche, J. W., Ma, Q., Rungee, J., and Bales, R. C.: Evapotranspiration mapping for forest management in California's Sierra Nevada, Frontiers for Global Change, https://doi.org/10.3389/ffgc.2020.00069, 2020.

Thomas, H. A.: Improved methods for national water assessment, water resources contract: WR15249270, Tech. rep., U.S. Geological Survey, https://doi.org/10.3133/70046351, 1981.

Wang, D. and Tang, Y.: A one-parameter Budyko model for water balance captures emergent behavior in darwinian hydrologic models, Geophysical Research Letters, 41, 4569–4577, https://doi.org/10.1002/2014GL060509, 2014.