Simulated 1922-2009 Daily Inflows to the Sacramento – San Joaquin Delta under Predevelopment Conditions using Precipitation – Runoff Models and C2VSIM: Preliminary Results

California Water and Environmental Modeling Forum

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- Can Dogrul (CA DWR)
- Charles Brush (CA DWR)
- Jane Schafer-Kramer (CA DWR)
- Francis Chung (CA DWR)

Outline

- Objective
- Tools and data
- Approach
- Preliminary results
- Concluding remarks and future work

Objective

To develop a consistent set of tools to estimate predevelopment conditions daily inflows/outflows to the Sacramento – San Joaquin Delta for the historical period WY1922-2009 (and beyond) and would allow the study of climate change impacts on these flows

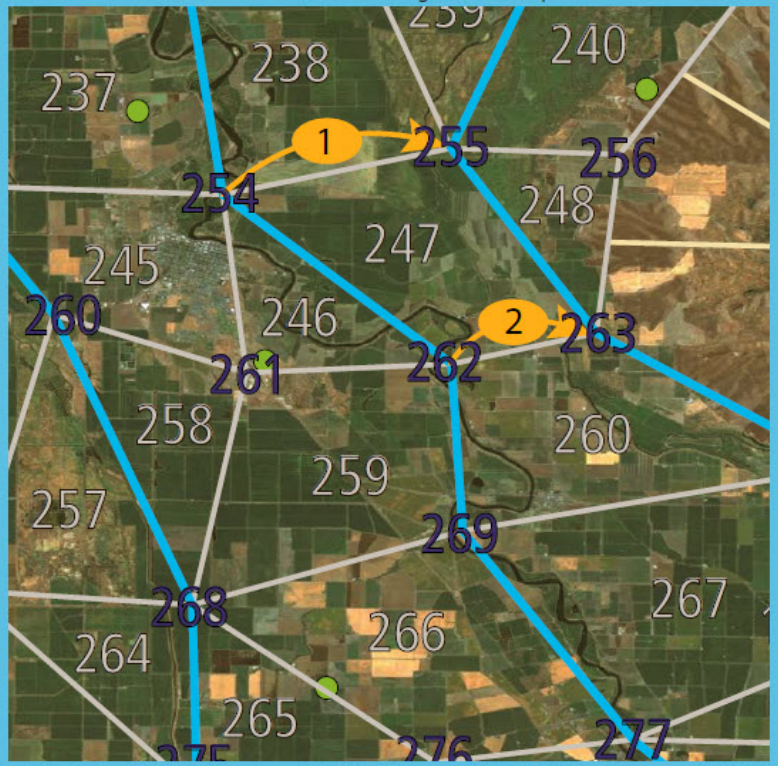
Tools and Data

- Precipitation/Snowmelt runoff models for upper watersheds (SWAT)
- C2VSIM model adapted to predevelopment land use conditions
- IWFM v4.1 with enhancements for ground water uptake, riparian access to streams, interconnected lakes/wetlands
- Data:
  - Precipitation and Potential Evapotranspiration ETo:
    - Upper watersheds: PRISM monthly, DAYMET & U.Wash. daily
    - Valley floor: SIMETAW-II 4-km grid resolution database
  - Land Use (valley floor): Chico State University study (pre-1900)

DWR Technical Memorandum

Development and Calibration of the California Central Valley Groundwater-Surface Water Simulation Model (C2VSim), Version 3.02-CG

Charles F. Brush, Emin C. Dogrul and Tariq N. Kadir



Bay-Delta Office, California Department of Water Resources, 1416 Ninth Street, Sacramento, CA 95814
C2VSim-CG Version R374, released June 2013

Figure 1. Location of the C2VSim model.

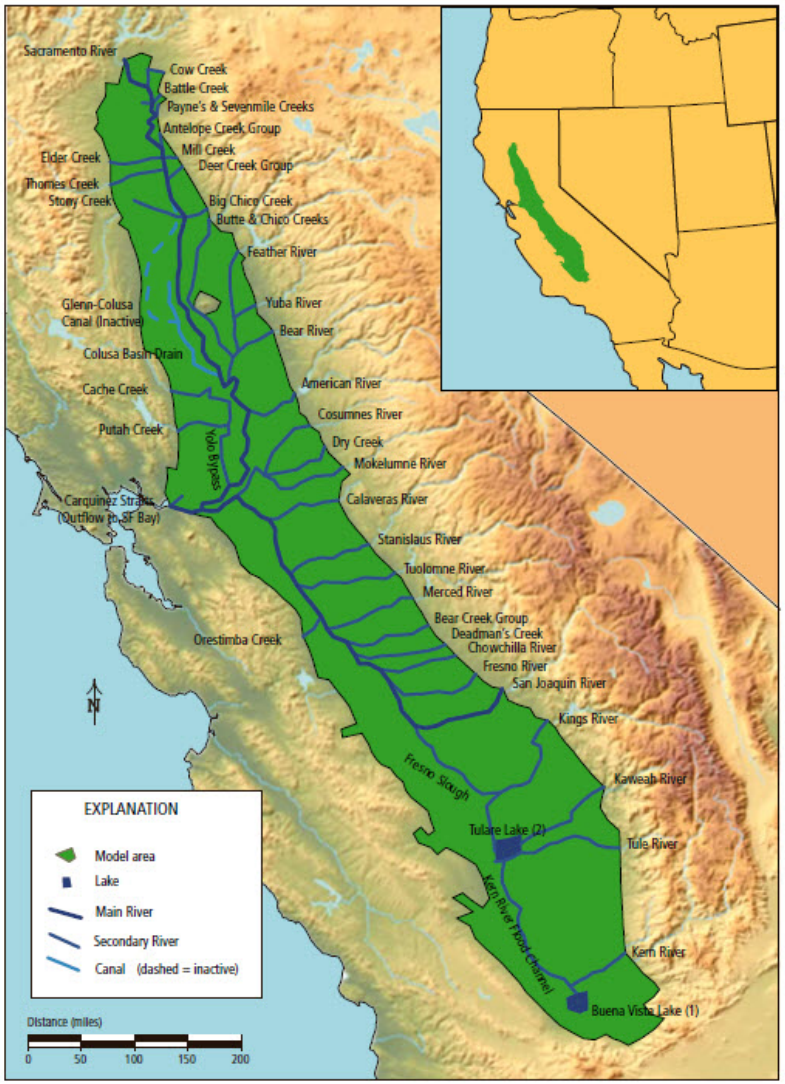


Figure 12. C2VSim coarse-grid model framework.

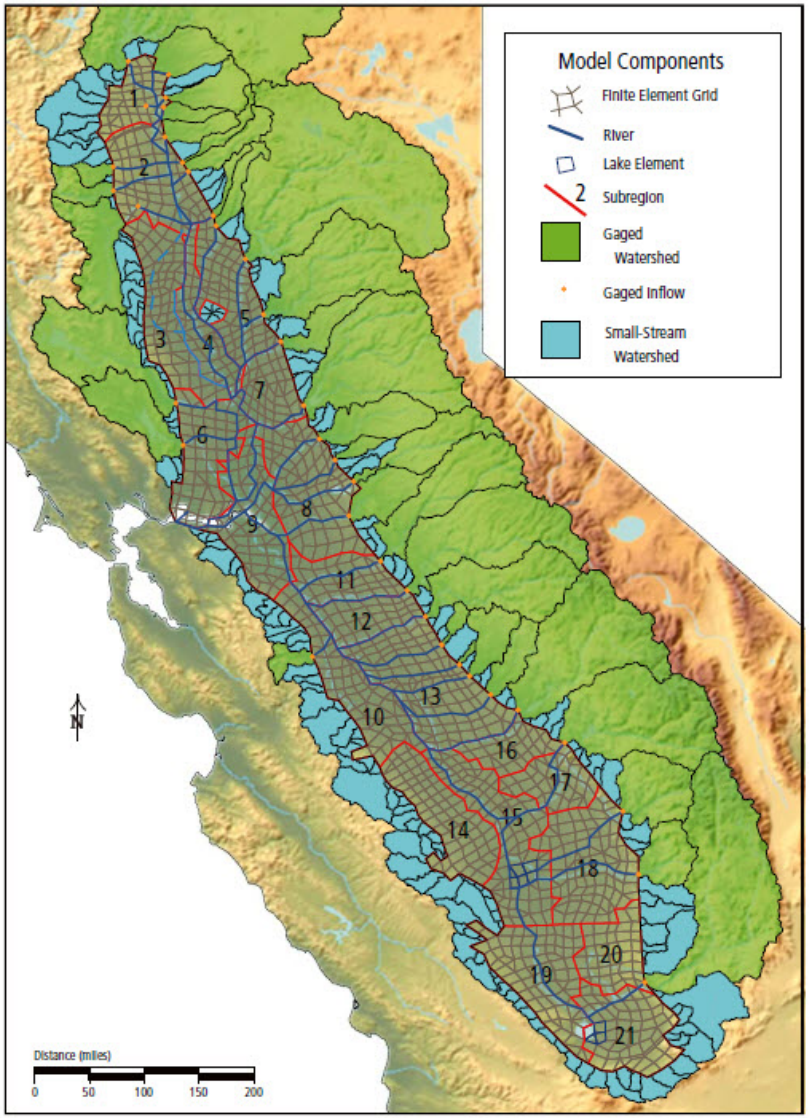


Figure 2. The California Central Valley watershed.

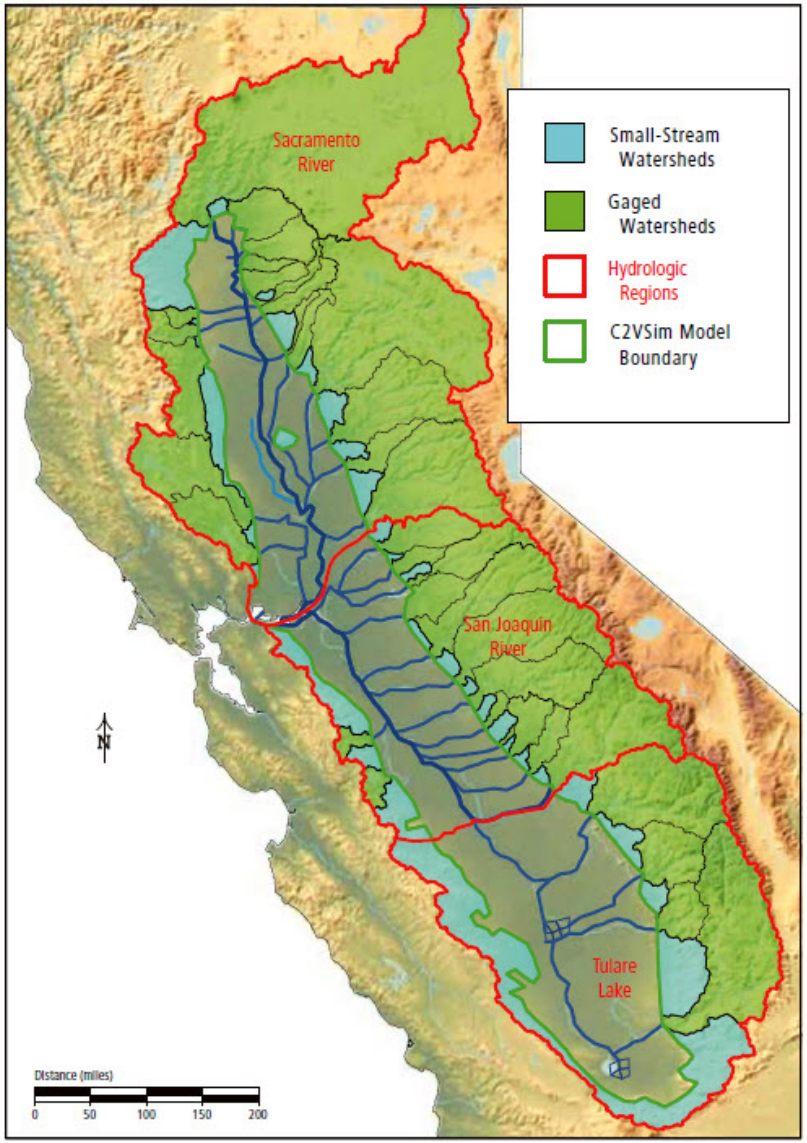
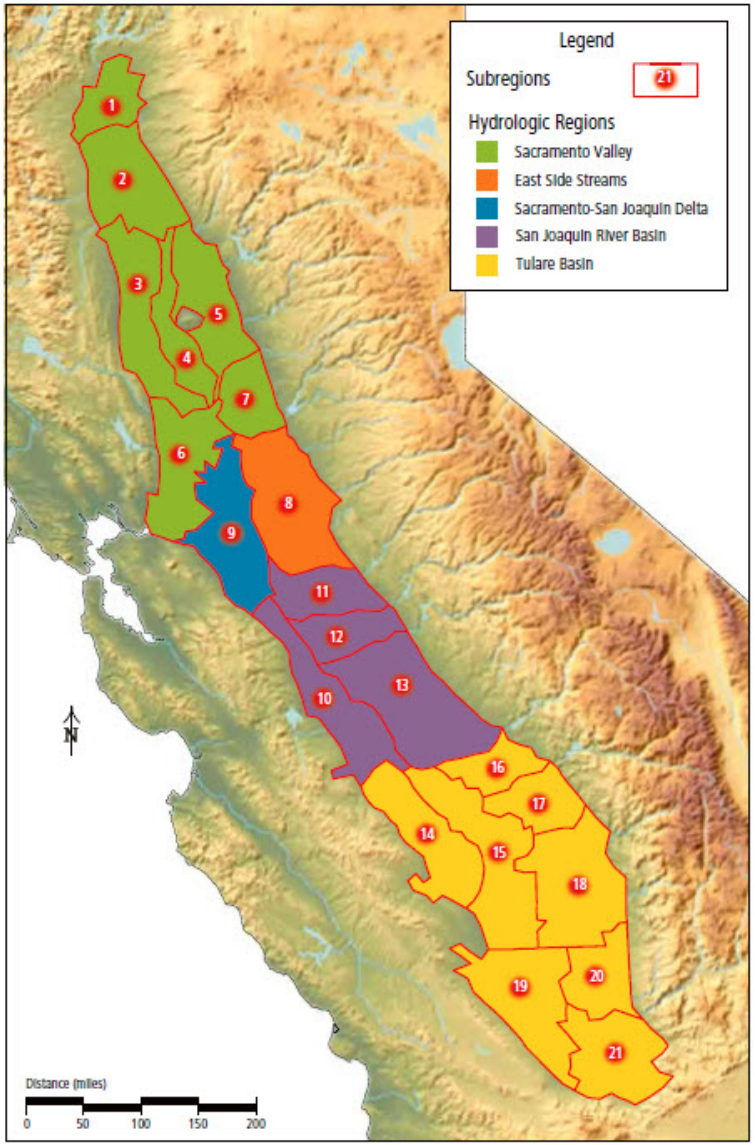
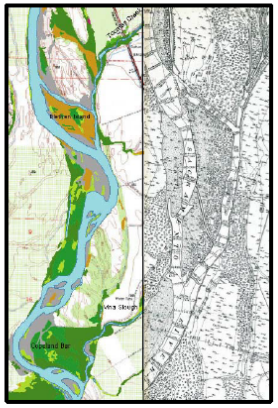


Figure 3. C2VSim model subregions and hydrologic regions.



THE CENTRAL VALLEY HISTORIC MAPPING PROJECT

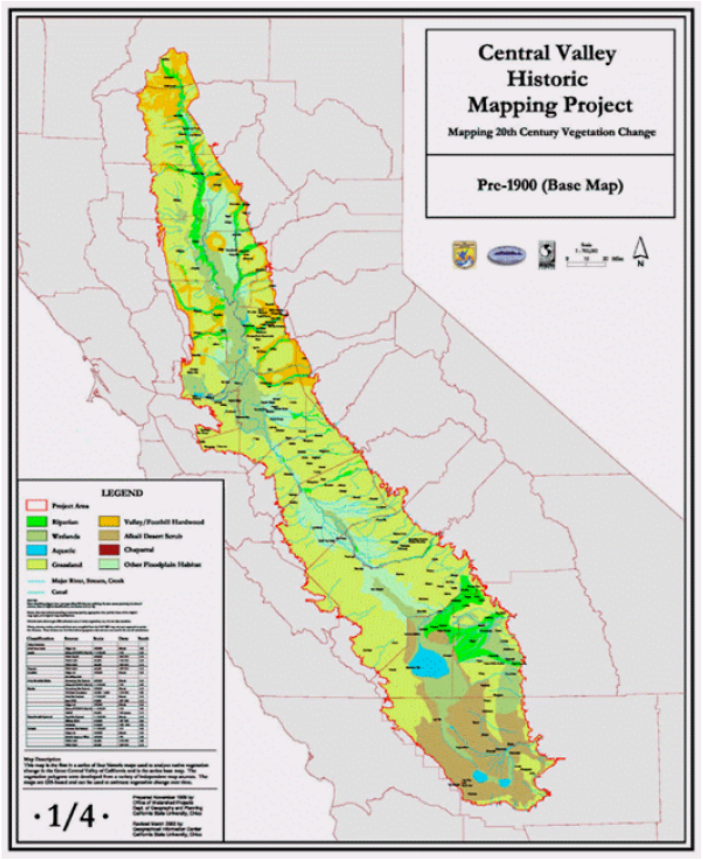


By

California State University, Chico
Department of Geography and Planning and
Geographic Information Center

April, 2003

Figure 2 - Historic Vegetation Base Map (Pre-1900)



This historic vegetation map consists of the best available historical vegetation information for the pre-1900 period. It is a patchwork of sources, scales, and dates. A date has not been assigned to this base map, as it would add confusion to the querying function of the GIS (The earliest source map is dated 1874). However, given the information available, the Pre-1900 map provides a snapshot of the most likely pre Euro-American vegetation cover.

Approach

1. SWAT daily models for 23 major upper watersheds calibrated and verified for 1922-2009 with observed/computed data (monthly, spot check for daily). Minor upper/boundary watersheds modeled within C2VSIM. Compute daily runoffs.

2. Route upper watershed outflows to the Delta using daily C2VSIM:
   - Land use: Native vegetation, riparian vegetation, wetlands and lakes (CSU)
   - DEM: coarse grid (~ 5miles x 5 miles)
   - Rating curves to allow water flow from streams to lakes/wetlands
   - Connected lakes and wetlands (< 10 ft depth) with flow back to streams
   - Higher Etc for lakes/wetlands to reflect cattails, etc
   - Carry out sensitivity runs to reflect Base ETc, 1.2*Base, 1.5*Base, and 2.0*Base

Preliminary Results

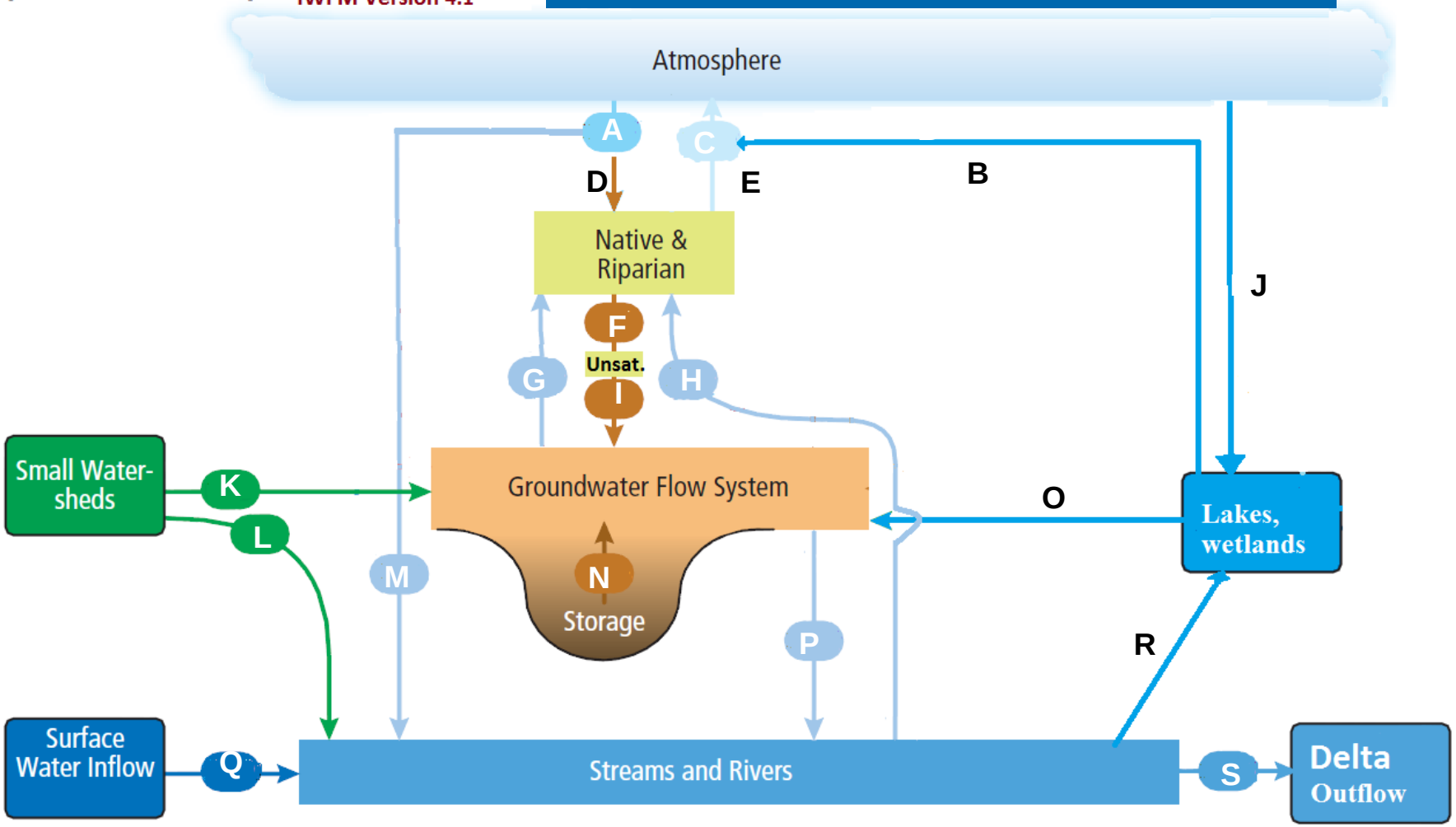
Simulated Annual Water Budget

Pre-Development condition

Average Flows for water years **1922-2009**
[Million Acre-Feet/Year]

IWFM Version 4.1

Sacramento-San Joaquin Valley and Delta



Flow Component	Definition
A	Precipitation
B	Evaporation from lakes and wetlands
C	Total ET and Evaporation
D	Precipitation to native and riparian vegetation (N&RV)
E	ET from native and riparian vegetation
F	Deep percolation below root zone from N&RV
G	Ground water uptake to N&RV
H	Stream flow to riparian vegetation
I	Net deep percolation from N&RV (unsaturated zone to GW)
J	Precipitation on lakes and wetlands
K	Boundary small watersheds to valley floor ground water
L	Boundary small watersheds to valley floor streams
M	Precipitation runoff to streams
N	Increase in ground water storage
O	Net deep percolation from lakes and wetlands
P	Seepage from ground water to streams
Q	Major stream inflows to valley floor (SWAT models outflows)
R	Flows from streams to lakes and wetlands
S	Delta inflow
T	Change in storage in the root zone
U	Change in storage in lakes
V	Subsurface GW flow from Sacramento River Basin to Eastside Streams and Delta

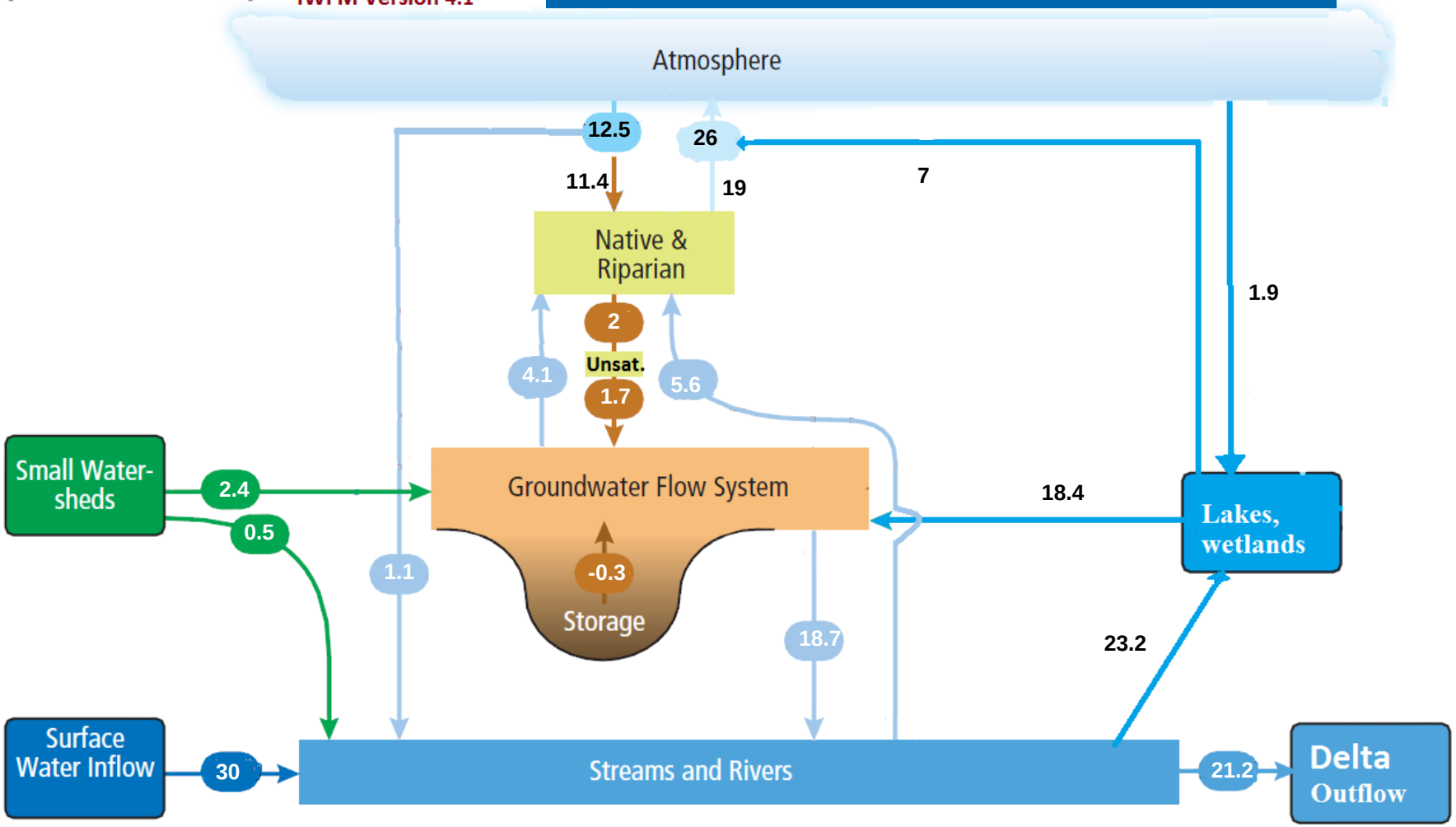
Simulated Annual Water Budget

Pre-Development condition

Average Flows for water years **1922-2009**
[Million Acre-Feet/Year]

IWFM Version 4.1

Sacramento-San Joaquin Valley and Delta

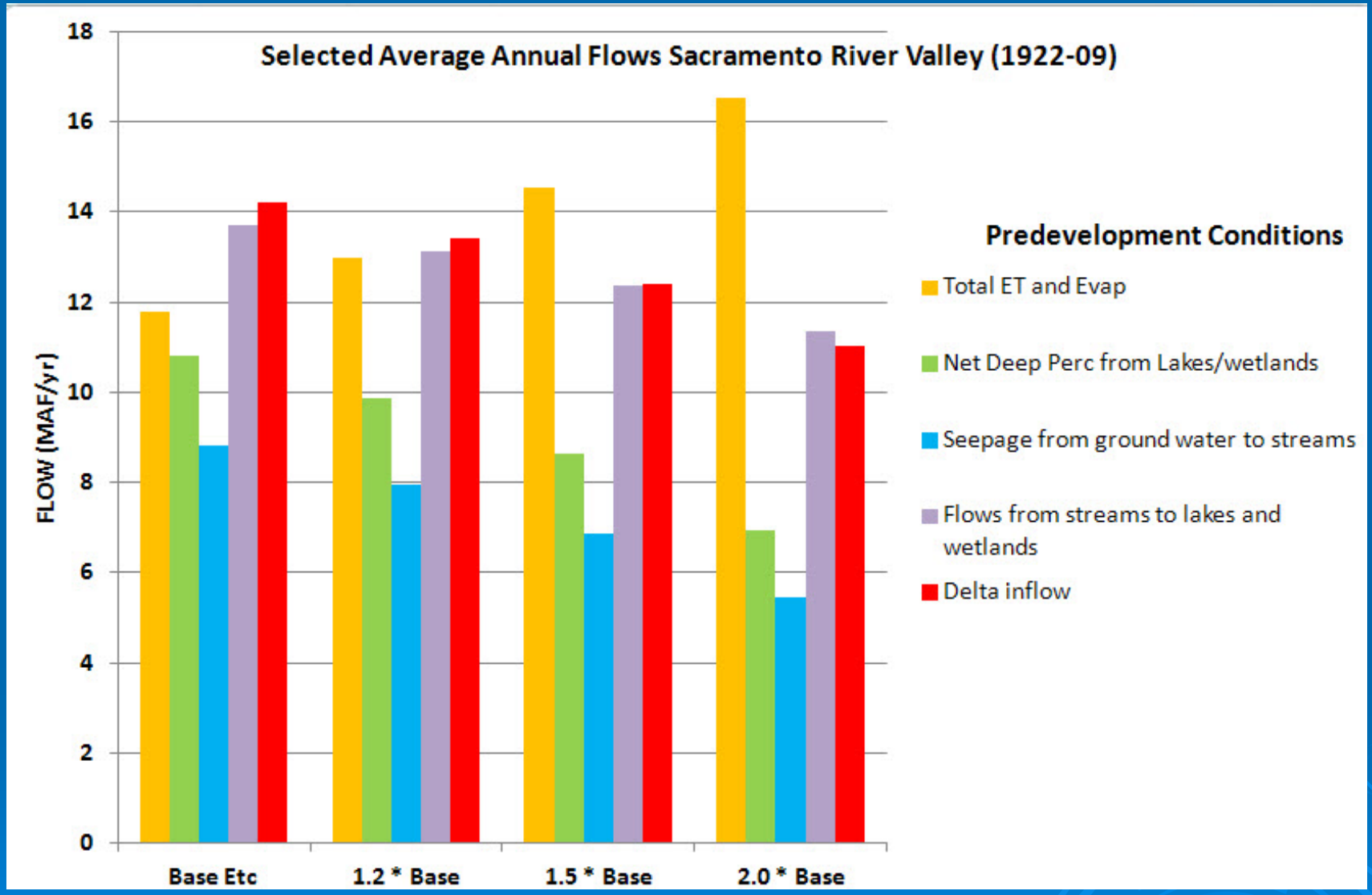


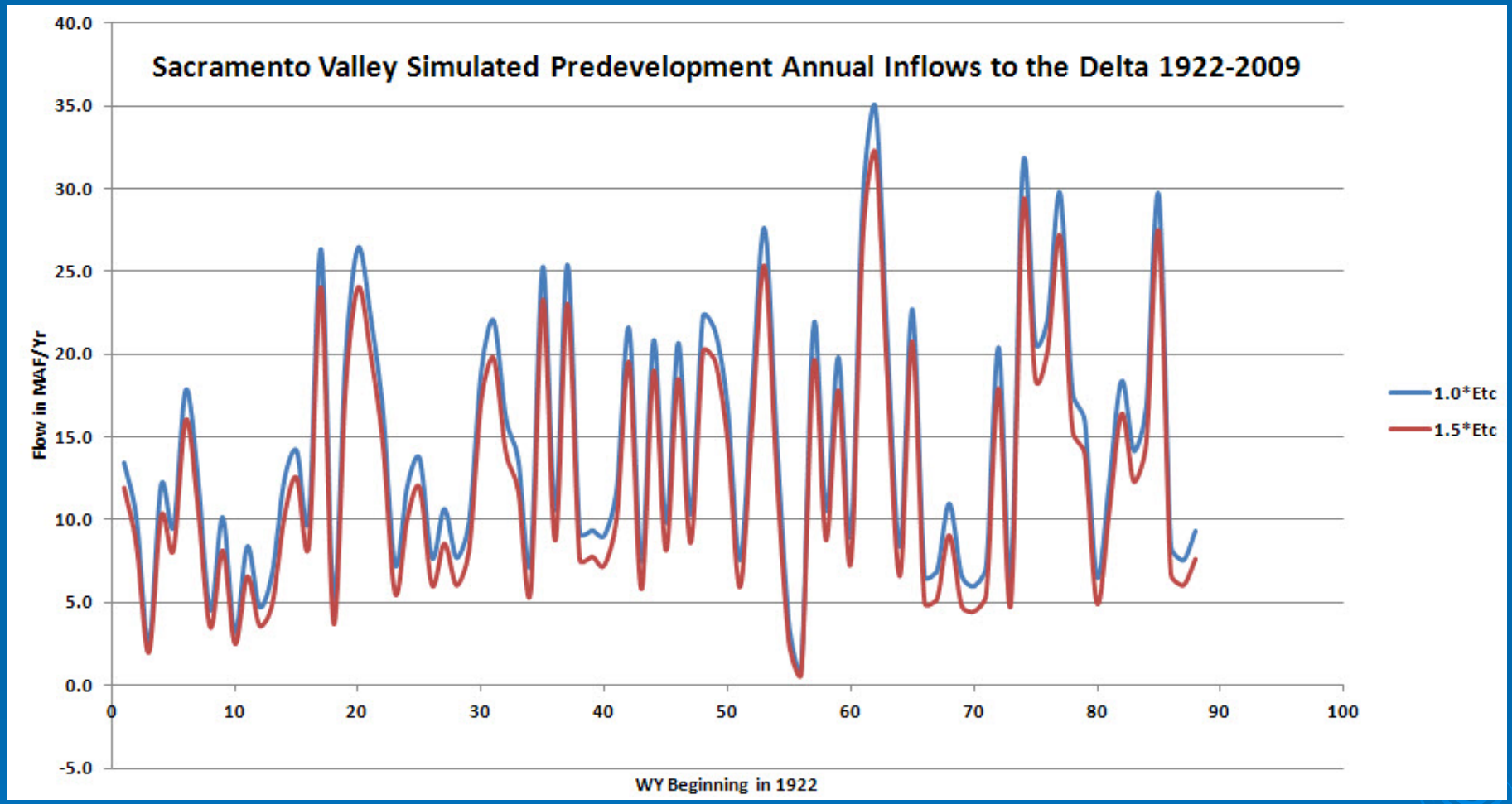
Budget for Central Valley (1922-2009) MAF/yr

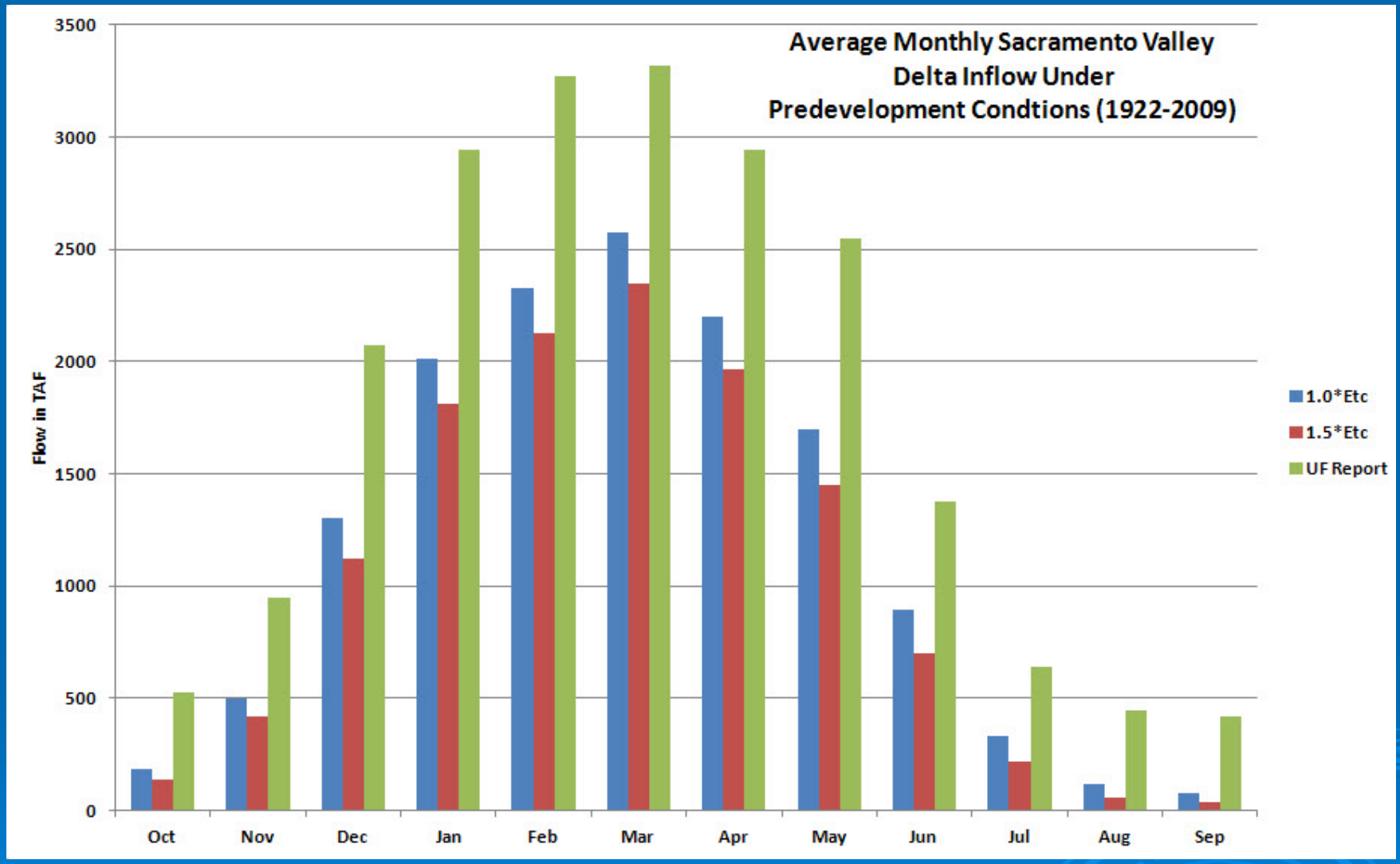
Abbreviated Definition	Flow Term	Base Etc	1.2 * Base	1.5 * Base	2.0 * Base
Precipitation	A	12.5	12.5	12.5	12.5
ET Lakes and Wetlands	B	7.0	8.1	9.5	11.5
Total ET and Evaporation	C	26.0	28.1	30.8	34.4
Precipitation to R&NV	D	11.4	11.4	11.5	11.5
ET from R&NV	E	19.0	20.0	21.3	23.0
Deep Percolation from R&NV	F	2.0	1.8	1.5	1.1
GW Uptake from R&NV	G	4.1	4.1	4.0	3.8
Streamflow to Riparian	H	5.6	6.4	7.4	8.9
Deep Percolation to GW from R&NV	I	1.7	1.5	1.2	0.9
Precipitation on Lakes and Wetlands	J	1.9	1.9	1.9	1.9
Small watersheds to GW	K	2.4	2.2	2.0	1.8
Small watersheds to Streams	L	0.5	0.5	0.4	0.3
Precipitation Runoff	M	1.1	1.0	1.0	0.9
Increase in GW Storage	N	-0.3	-0.5	-0.6	-0.8
Deep Perc to GW below lakes and Wetlands	O	18.4	17.3	15.6	12.6
Seepage Ground Water to Streams	P	18.7	17.4	15.5	12.3
SWAT Models Outflows to Valley Floor	Q	30.0	30.0	30.0	30.0
Streams to Lakes and Wetlands	R	23.2	23.3	23.2	22.0
Delta Outflow	S	21.2	19.0	16.2	12.5

Budget for Sacramento Valley (1922-2009) MAF/yr

Abbreviated Definition	Flow Term	Base Etc	1.2 * Base	1.5 * Base	2.0 * Base
Precipitation	A	5.6	5.6	5.6	5.6
ET Lakes and Wetlands	B	3.9	4.5	5.2	6.1
Total ET and Evaporation	C	11.8	13.0	14.5	16.5
Precipitation to R&NV	D	4.8	4.9	4.9	4.9
ET from R&NV	E	7.8	8.5	9.4	10.5
Deep Percolation from R&NV	F	1.5	1.3	1.2	0.9
GW Uptake from R&NV	G	2.4	2.4	2.4	2.3
Streamflow to Riparian	H	2.1	2.6	3.2	4.0
Deep Percolation to GW from R&NV	I	1.3	1.2	1.0	0.7
Precipitation on Lakes and Wetlands	J	1.2	1.2	1.2	1.2
Small watersheds to GW	K	1.5	1.5	1.4	1.3
Small watersheds to Streams	L	0.4	0.3	0.3	0.2
Precipitation Runoff	M	0.7	0.7	0.7	0.6
Increase in GW Storage	N	-0.2	-0.3	-0.3	-0.4
Deep Perc to GW below lakes and Wetlands	O	10.8	9.9	8.6	6.9
Seepage Ground Water to Streams	P	8.8	8.0	6.9	5.5
SWAT Models Outflows to Valley Floor	Q	20.1	20.1	20.1	20.1
Streams to Lakes and Wetlands	R	13.7	13.1	12.4	11.4
Delta Inflow	S	14.2	13.4	12.4	11.0


Selected Average Annual Flows Sacramento River Valley (1922-09)
FLOW (MAF/yr)
18
16
14
12
10
8
6
4
2
0
Base Etc
1.2 * Base
1.5 * Base
2.0 * Base
Predevelopment Conditions
Total ET and Evap
Net Deep Perc from Lakes/wetlands
Seepage from ground water to streams
Flows from streams to lakes and wetlands
Delta inflow


Sacramento Valley Simulated Predevelopment Annual Inflows to the Delta 1922-2009
Flow in MAF/Yr
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
-5.0
0
10
20
30
40
50
60
70
80
90
100
WY Beginning in 1922
1.0*Etc
1.5*Etc


Average Monthly Sacramento Valley Delta Inflow Under Predevelopment Condtions (1922-2009)
Flow in TAF
3500
3000
2500
2000
1500
1000
500
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
1.0*Etc
1.5*Etc
UF Report

Concluding Remarks and Future Work

- Development of 20 plus daily SWAT models to simulate all major upper watersheds in the Central Valley tributary to the Delta for the historical period 1922-2009
- Routing the upper watershed outflows through the valley floor and compute daily Delta inflows and outflows
- SWAT and C2VSIM models allow applications to future conditions to study impacts of climate change (precipitation, temperature, Etc)
- Include latest enhancement to IWFM: stream routing (kinematic wave)
- Use C2VSIM fine grid model
- Better model the landscape, levees (overtopping), and consumptive requirements
- Extend work to include different levels of land use development (e.g., 1920, 1945, 2000, 2020, 2050, etc)
- Continue collaborative work with USGS (Lorrie and Alan Flint, Basin Characteristics Model)

Thank you

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