Progress Report

Quantifying pesticide and nitrogen loadings to Delta from the Sacramento and San Joaquin River watersheds using SWAT, February 2018

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DRAAWP agencies in collaboration: National Aeronautics and Space Administration (NASA), Ames Research Center

Goals/objectives:
To provide quantitative information on pesticide and nitrate loadings from the Sacramento and the San Joaquin River watersheds into the Sacramento-San Joaquin Delta waterways using the Soil and Water Assessment Tool (SWAT).

Progress since the project began (July 2014):

- The total area of the Sacramento and San Joaquin River watersheds, as defined in this project, is about 23,300 and 15,000 km^2, respectively. The watersheds were divided into subbasins, and further partitioned into Hydrologic Response Units (HRUs), based on the unique combination of land use, soil, and slope (Figure 1).
- Pesticide use data were retrieved from the Pesticide Use Reporting (PUR) database. Results show that the calibrated SWAT was able to successfully simulate streamflow, sediment and pesticide diuron in both the Sacramento and the San Joaquin River watershed [*Chen et al.*, 2017].
- Nitrate load simulation was also carried out in both the Sacramento and San Joaquin River watersheds. We estimated nitrogen fertilizer application rate for each crop type in the study area based on literature review and expert judgements. After calibration, nitrate dynamics are well reflected in both watersheds (Fig.2 and Fig.3). Model performance evaluation criteria are list in Table 1 and 2. Based on Moriasi et al., (2015), performance was rated as at least "satisfactory" by most metrics. Our results show that the calibrated SWAT is able to capture monthly nitrate loads in both the Sacramento and San Joaquin River watersheds. The calibrated model is able to provide continuous nitrate loadings entering the Delta, which is ready to couple with FAV/SAV growth model.
- In addition, tile drains have been installed in considerable portions of the Grassland Drainage Area (GDA) in the western San Joaquin River watershed. The presence of tile drains tends to enhance the delivery of nitrate from croplands to streams. We adopted the new tile drainage routine of SWAT in our study, which significantly improved the modeling performance in the San Joaquin River watershed.

- As an important abiotic constraint of aquatic weed growth, water temperature was also examined at the main outlet of the Sacramento River watershed (Fig. 4) for future model coupling purpose.

Products to Date:

Publications

Chen, H., Y. Luo, C. Potter, P. Moran, M. Grieneisen, and M. Zhang. 2017. Modeling pesticide diuron loading from the San Joaquin watershed into the Sacramento-San Joaquin Delta using SWAT. *Water Research* 121: 374-385.

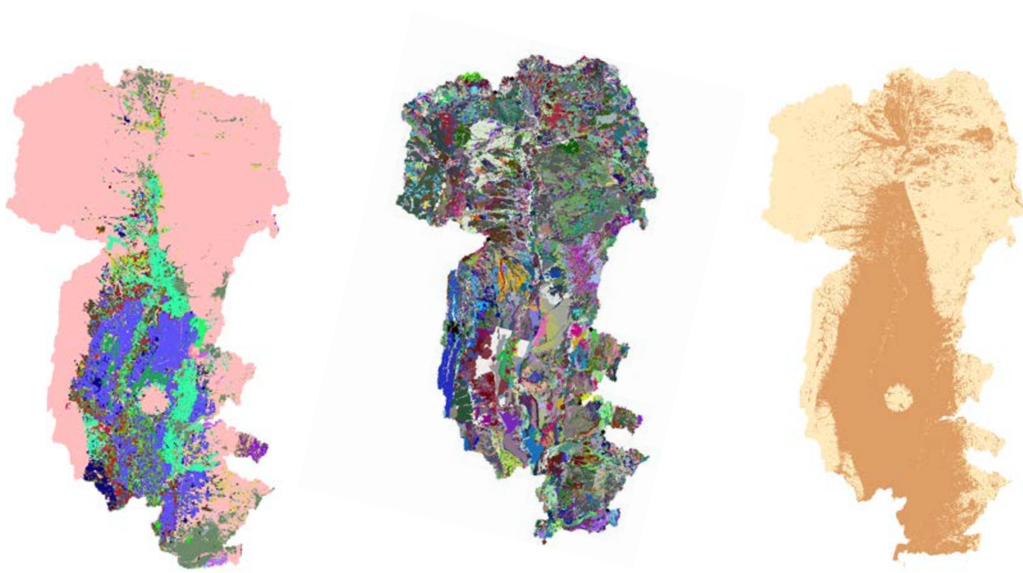
Presentations

Chen, H., Y. Luo, and M. Zhang. (2017). *Modeling pesticide loadings from the San Joaquin watershed using SWAT.* American Chemical Society National Meeting in San Francisco.
Chen, H., and M. Zhang. (2016). *Modeling pesticide loadings from the San Joaquin watershed into the Sacramento-San Joaquin Delta using SWAT*. American Geophysical Union Fall Meeting in San Francisco.

Models

Calibrated SWAT for pesticide diuron and nitrate simulation at both the Sacramento and San Joaquin River watersheds.

Figures and tables:



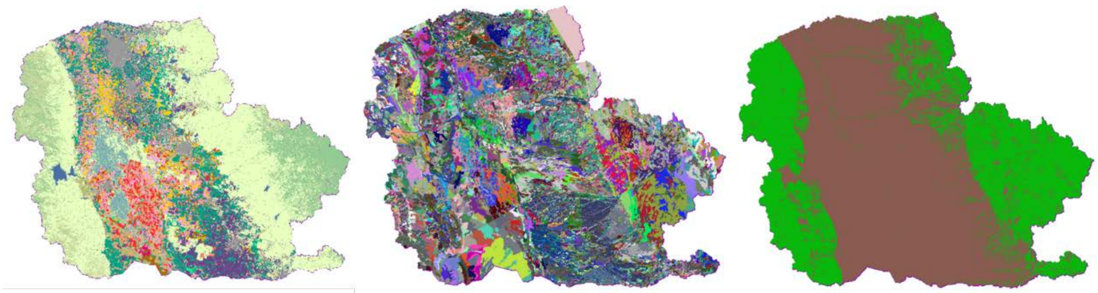


Figure 1. Land use, soil, and slope maps of the a) Sacramento and b) San Joaquin River watersheds.

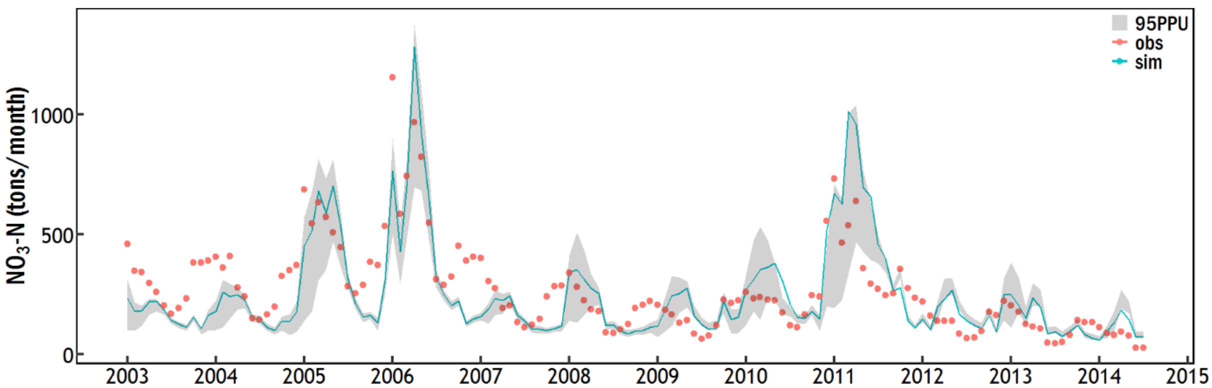


Figure 2. Observed (obs), simulated (sim), and the 95% prediction uncertainty (95PPU) of monthly nitrate loads for the San Joaquin River near Vernalis.

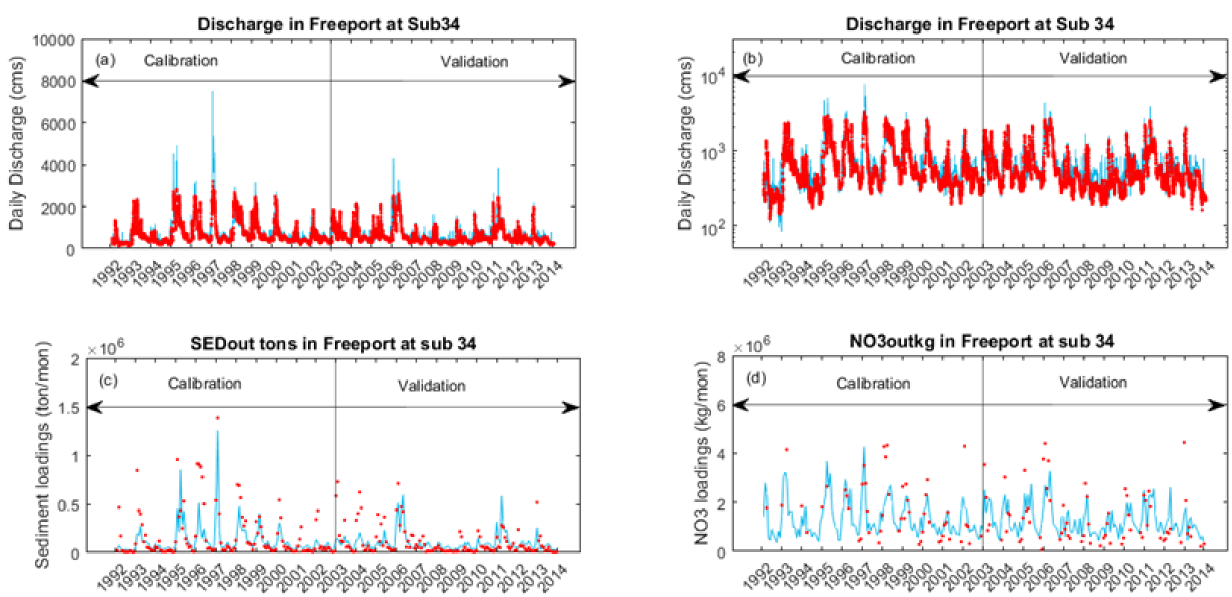


Figure 3. Obs vs. Sim daily flow: a) linear scale; b) log scale. c) Obs vs. Sim monthly sediment loads; d) Nitrate loads at Freeport, CA, main outlet of the Sacramento River watershed.

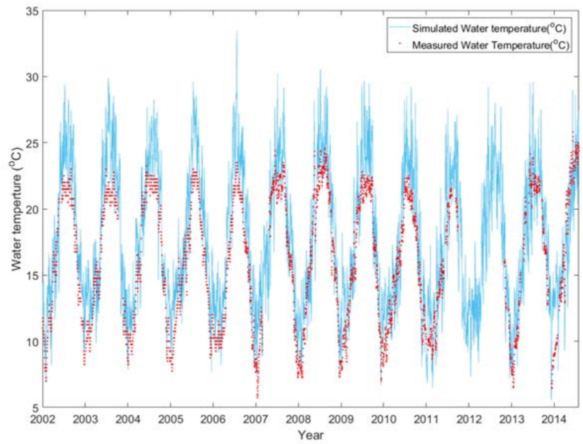


Fig. 4 SWAT evaluation in water temperature at Freeport, CA

Table 1. Statistics of SWAT performance in the San Joaquin River watershed

Station	*P-factor*	*R-factor*	R^2	R^2 rating	*NSE*	*NSE* rating	*PBIAS* (%)	*PBIAS* rating
Calibration of nitrate simulation (2003-2008)								
Vernalis	0.53	0.63	0.68	Good	0.45	Satisfactory	-22	Satisfactory
Fremont	0.56	1.72	0.67	Good	-0.11	Unsatisfactory	16	Good
Validation of nitrate simulation (2009-2014)								
Vernalis	0.51	0.86	0.71	Very good	0.25	Unsatisfactory	24	Satisfactory
Fremont	0.67	1.82	0.52	Satisfactory	-0.73	Unsatisfactory	29	Satisfactory

Table 2. Statistics of SWAT performance in three subbasins and the main outlet of Sacramento River watershed

		Calibration			**Validation**		
		MBE	R^2	*NSE*	*MBE*	R^2	*NSE*
Red Bluff	Monthly flow	0.004	0.970	0.940	0.032	0.933	0.913
	Daily flow	-0.002	0.765	0.743	0.029	0.674	0.649
Hamilton City	Monthly flow	0.120	0.918	0.868	0.293	0.858	0.564
Verona	Monthly flow	0.032	0.854	0.843	0.078	0.823	0.795
	Daily flow	0.031	0.692	0.674	0.079	0.665	0.632
	Sediment	X	X	X	-0.061	0.673	0.633
	NO3	X	X	X	-0.037	0.483	0.449
Freeport (outlet)	Monthly flow	0.065	0.841	0.778	0.136	0.851	0.773
	Daily flow	0.063	0.698	0.629	0.137	0.707	0.629
	Sediment	-0.274	0.604	0.554	-0.038	0.462	0.461
	NO3	-0.016	0.523	0.519	0.077	0.489	0.472

References:

Moriasi, D.N., Gitau, M.W., Pai, N. and Daggupati, P., 2015. Hydrologic and water quality models: Performance measures and evaluation criteria. *Transactions of the ASABE*, 58(6): 1763-1785.