Technical Collaboration on Interconnected Subbasins to Advance Sustainable Groundwater Management

Assessment of Interconnected Subbasins

NSV Board Meeting
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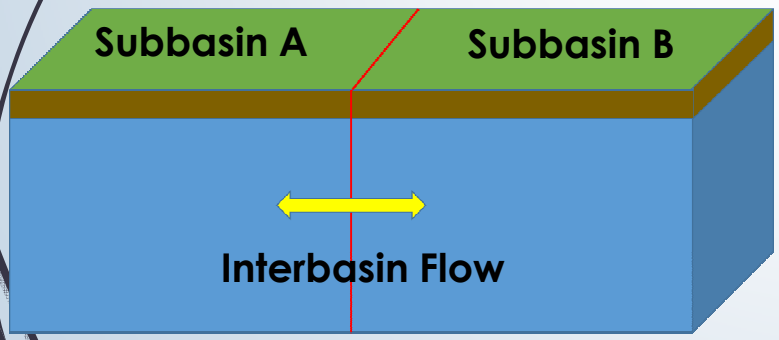
Project Motivation

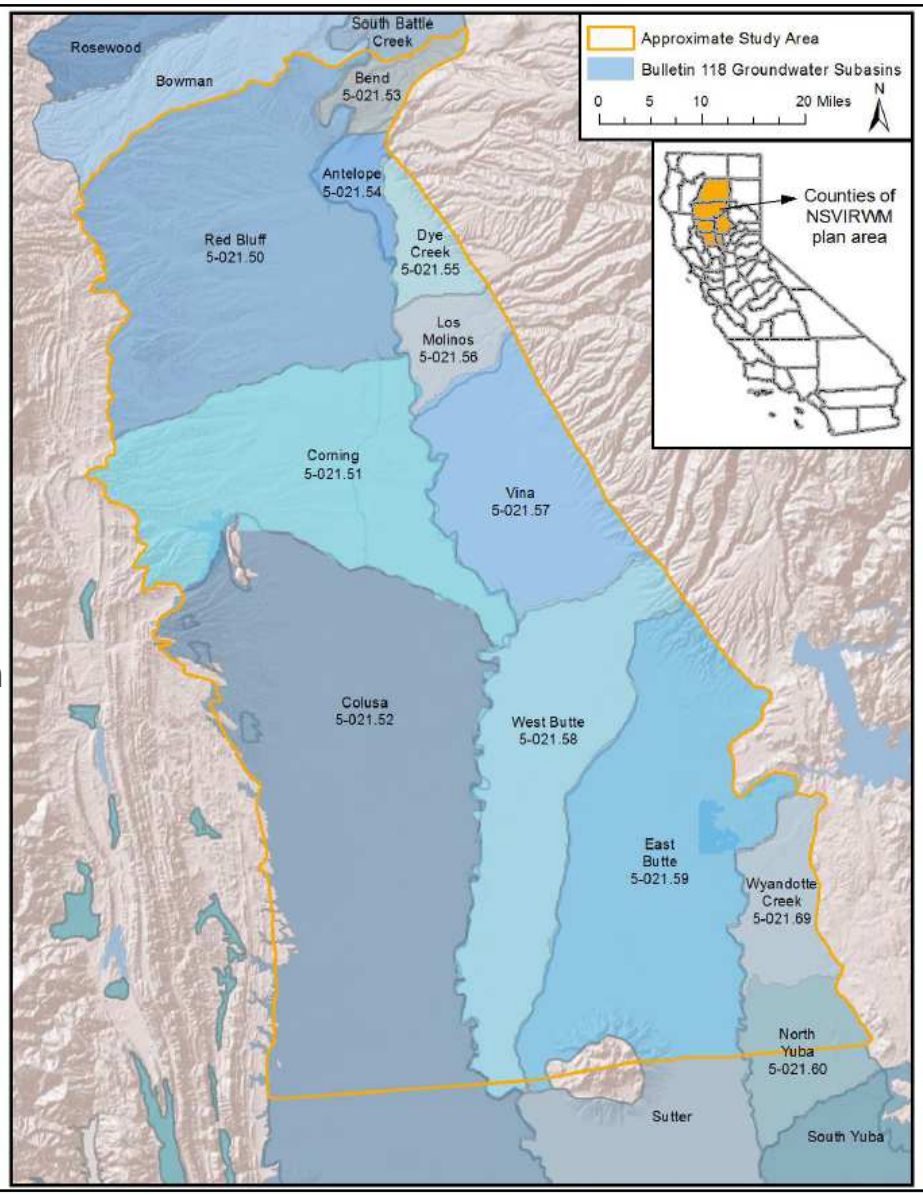
SGMA: Sustainable Groundwater Management Act

- Requires Groundwater Sustainability Agencies (**GSAs**) to develop Groundwater Sustainability Plans (**GSPs**) that achieve sustainable groundwater management within 20 years
- Requires development of water budgets, must include
  - Interbasin flows and stream-groundwater interaction

Hydrologically Interconnected Subbasins

- 12 subbasins in Study area
- Relevant to entire Central Valley
- Provide recommendations to GSAs on methodologies to account for interbasin interaction in their GSPs





Water Budgets are Required in Groundwater Sustainability Plan (GSP)

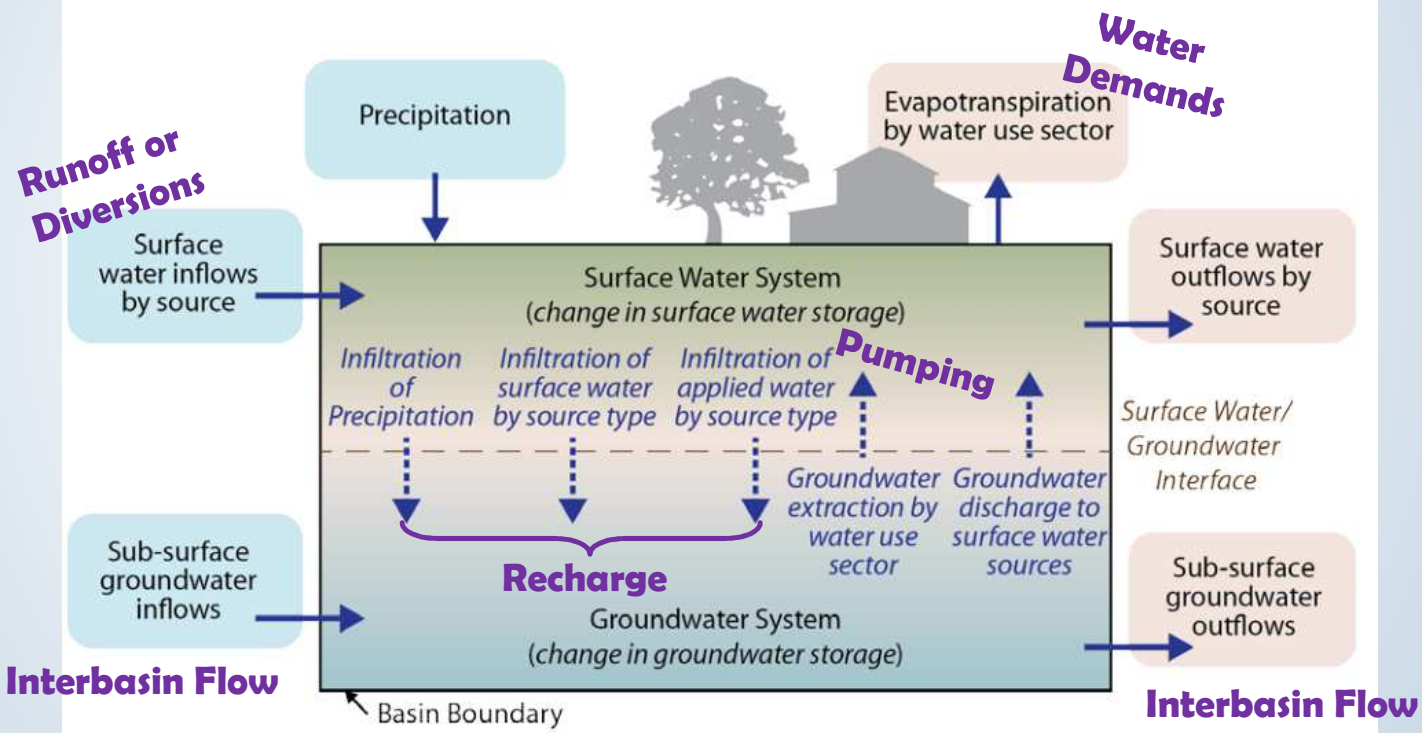
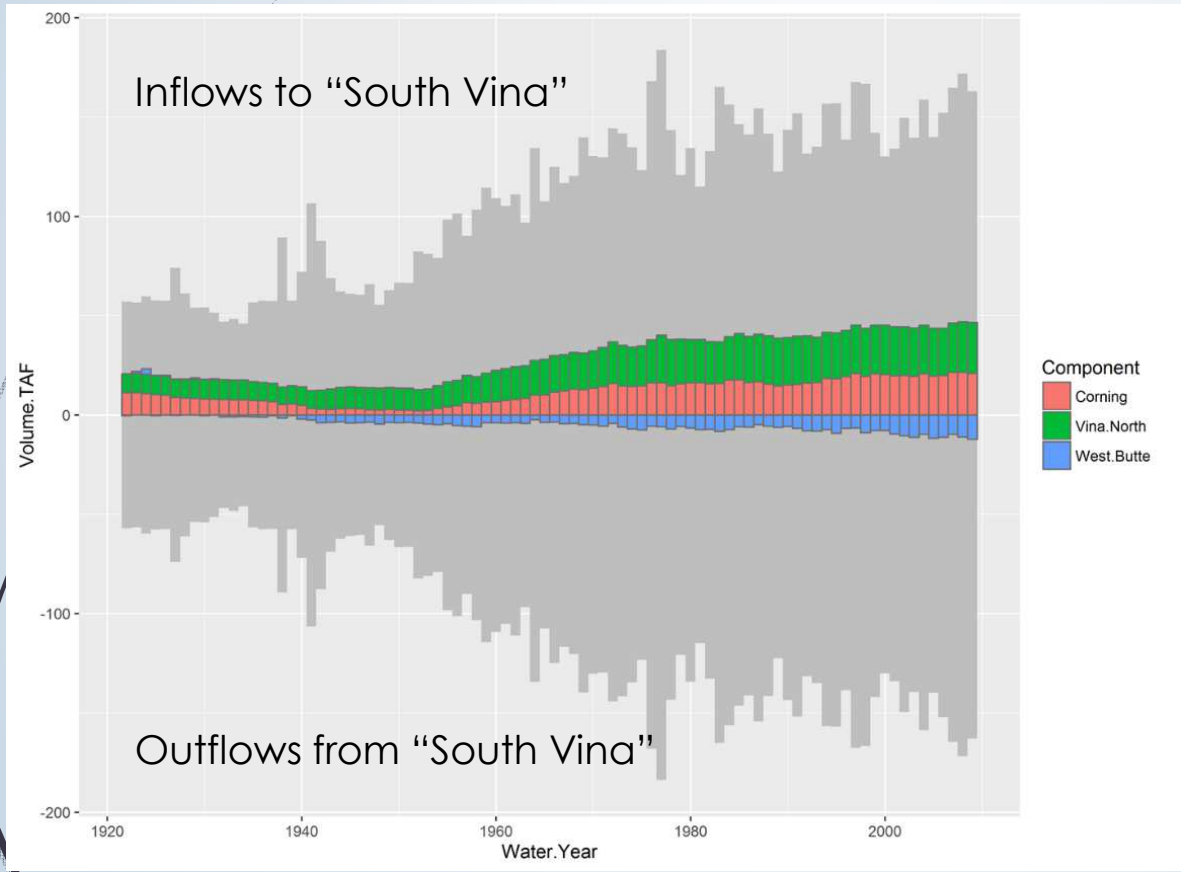
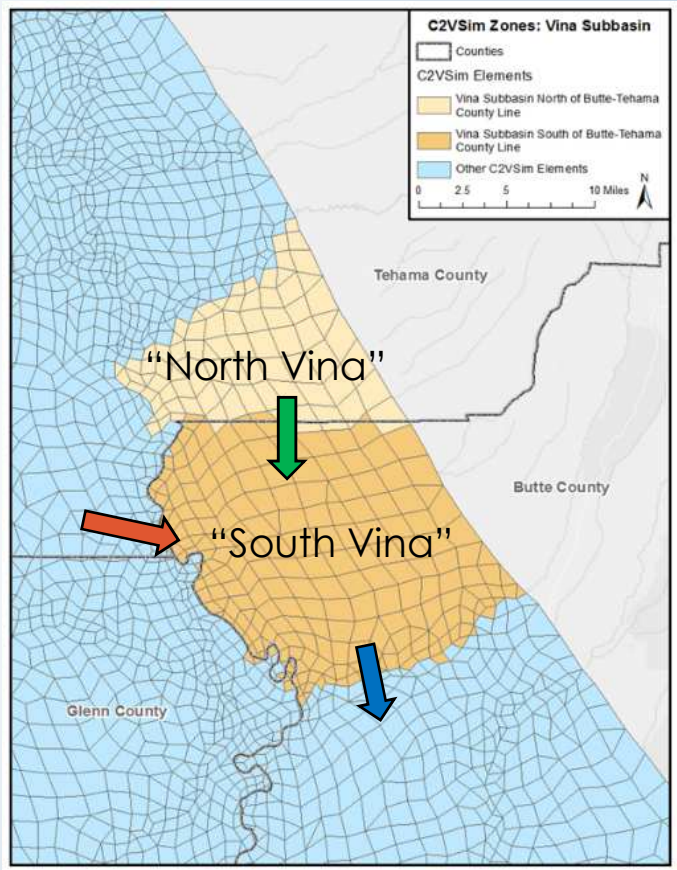


Figure 5 – Required Water Budget Components

From DWR Water Budget BMP

Interbasin Flows Example





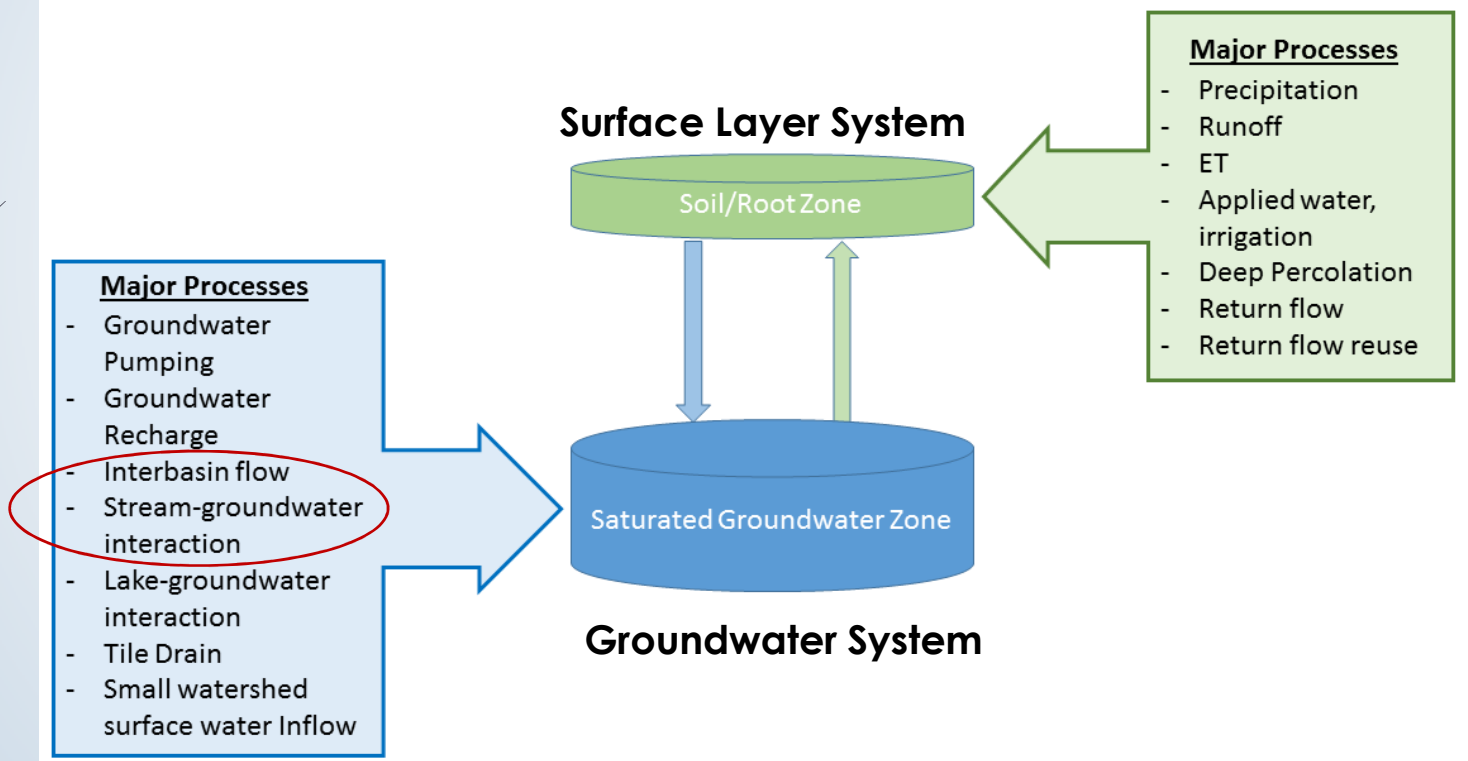
Technical Collaborators

Name	Organization	NSVIRWM TAC Member?
Charlie Brush	DWR Bay-Delta Office, Modeling Support Branch	
Christina Buck	Butte County Department of Water and Resource Conservation	
Grant Davids	Davids Engineering, Inc.	
Bill Ehorn	DWR Northern Region Office	✓
Claudia Faunt	United States Geological Survey	
Allan Fulton	University of California, Cooperative Extension	✓
Thomas Harter	University of California, Davis	
Peter Lawson	CH2M	
Steffen Mehl	California State University, Chico	
Vickie Newlin	Butte County Department of Water and Resource Conservation	✓
Ben Pennock	Glenn Colusa Irrigation District (Retired)	✓
Steve Phillips	United States Geological Survey	
Mary Randall	DWR Northern Region Office	
Oscar Serrano	Colusa Indian Community Council	✓
Ali Taghavi	RMC, a Woodard & Curran Company	

Important Finding

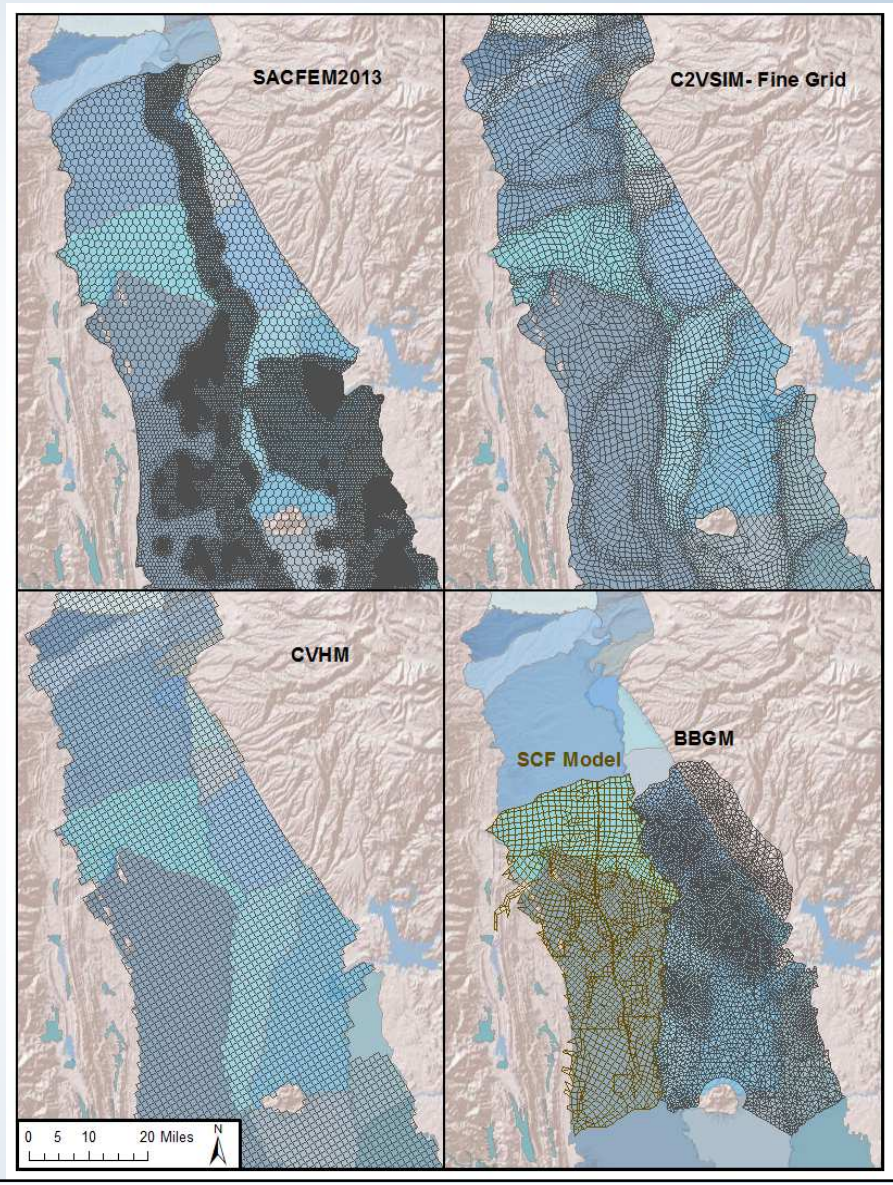
Although SGMA does not require use of a groundwater model, groundwater modeling is the best approach to quantify and evaluate interbasin groundwater flows given the complex spatial and temporal variations in basin water budget components (i.e. groundwater pumping, recharge, stream-groundwater interactions).

Why use an Integrated Groundwater-Surface Water Model?



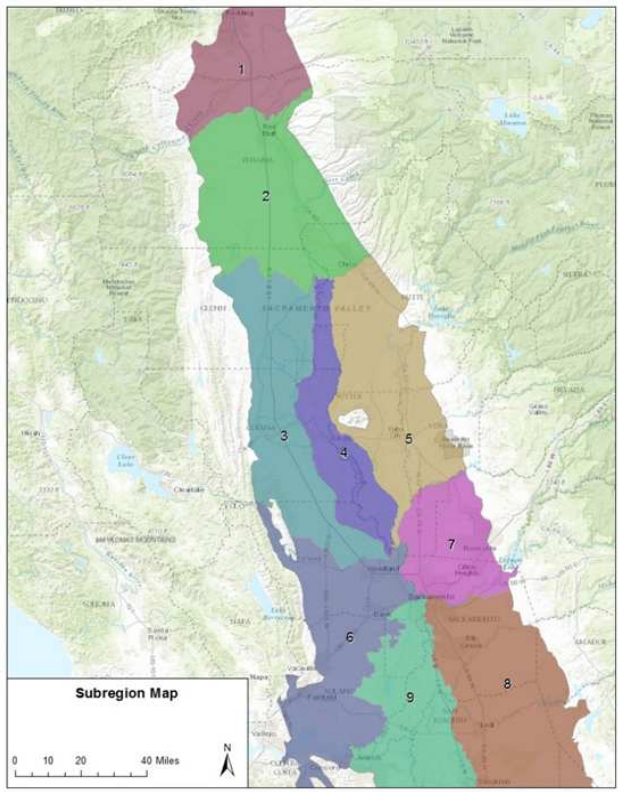
Existing Tools

- **All developed prior to SGMA for other purposes**
- SACFEM2013- not a fully integrated gw-sw model & proprietary. Not recommended for use.
- **C2VSIM-** developed by DWR, IWFM code, currently being updated
- **CVHM-** developed by USGS, MODFLOW code, currently being updated
- BBGM- Butte County, IWFM code, currently being updated
- SCF Model- DWR, IGSM code. Not actively being used/updated.
- SVSim- DWR, IWFM code. Under development
- **Focus: C2VSim & CVHM**



Model Comparison Challenges: C2VSim and CVHM

- Extracting water budget components and data inputs (e.g. crop acreages) for groundwater subbasins can be difficult
- Differences in conceptualization of hydrological processes
- Differences in terminology and what is reported in output files…hard to know if you're comparing apples to apples
- Account for stream recharge differently in their model water budgets
- **Both are undergoing significant updates with plans to release new versions in the coming year**



Shared subregions for data input and model output in CVHM and C2VSim- do not correspond to groundwater subbasins

Model Comparison & Selection

- **Not an obvious choice between CVHM and C2VSim for the NSV region as a whole**
  - Significant differences in land use and crop acreage inputs (although, they are more similar in recent years)
  - Significant differences in estimates of water budget components
  - Significant differences in simulated groundwater levels and how they compare to historical data

Differences in land use inputs

Ag Area for CVHM and C2VSim in the Sacramento Valley

Year	Agricultural Area (millions of acres)	
	CVHM	C2VSim
1960	2.02	0.99
1973	2.17	1.55
1992	2.49	1.55
1998	2.39	1.71
2000	1.73	1.75

Land Use Categories

CVHM		C2VSim
Citrus and sub-tropical		Alfalfa
Cotton		Citrus and Olives
Cropland		Cotton
Cropland and pasture		Field crops
Deciduous fruits and nuts		Grains
Developed		Native Vegetation
Field crops		Orchard
Grains and hay crops		Pasture
Idle/fallow		Rice
Irrigated row and field crops		Riparian Vegetation
Native Classes		Sugar beet
Orchards, groves, and vineyards		Tomato
Pasture		Tomato (hand-picked)
Pasture/hay		Tomato (machine picked)
Rice		Truck crops
Row crops		Urban
Semi-agriculture		Vineyard
Small grains		
Truck, nursery, and berry crops		
Urban		
Vineyards		
Water		

Table 6: Long-Term (1961-2003) Average Water Budget for Selected Components, Subregions 2, 3, 4, and 5

Water Budget Component	Basis in Model	Long Term Average Volume Subregions 2, 3, 4, and 5 (see Figure 8) (thousand acre-feet per year)
CVHM *note: differences in C2VSim and CVHM water budgets are largely due to both differences in data and terminology*		
Ag Water Required	Final Total Farm Delivery Requirement	1,928
Surface Diversion	Routed and Nonrouted Surface-Water Delivery	1,339
Pumping	Multi-Node Wells and Farm Wells	1,853
Groundwater Recharge	Net Farm Recharge	2,384
Stream Recharge	Stream Leakage	-1,021
C2VSim *note: differences in C2VSim and CVHM water budgets are largely due to both differences in data and in terminology*		
Ag Water Required	Agricultural Supply Requirement	3,491
Surface Diversion	Agricultural Diversion, Urban Diversion	3,126
Pumping	Agricultural Pumping, Urban Pumping	948
Groundwater Recharge	Net Deep Percolation and Recharge	876
Stream Recharge	Gain from Stream	-338

Model Comparison & Selection

- For available models, GSAs should consider:

  How well does the model match my current understanding of the surface layer and groundwater budget in my area?

  How well does the model match historical groundwater level conditions, particularly near subbasin boundaries?

- Local data important to help ground truth regional tools
- Select groundwater model that best reflects subbasin conditions
- Cooperate early with neighbors

Recommendations for GSAs in NSV

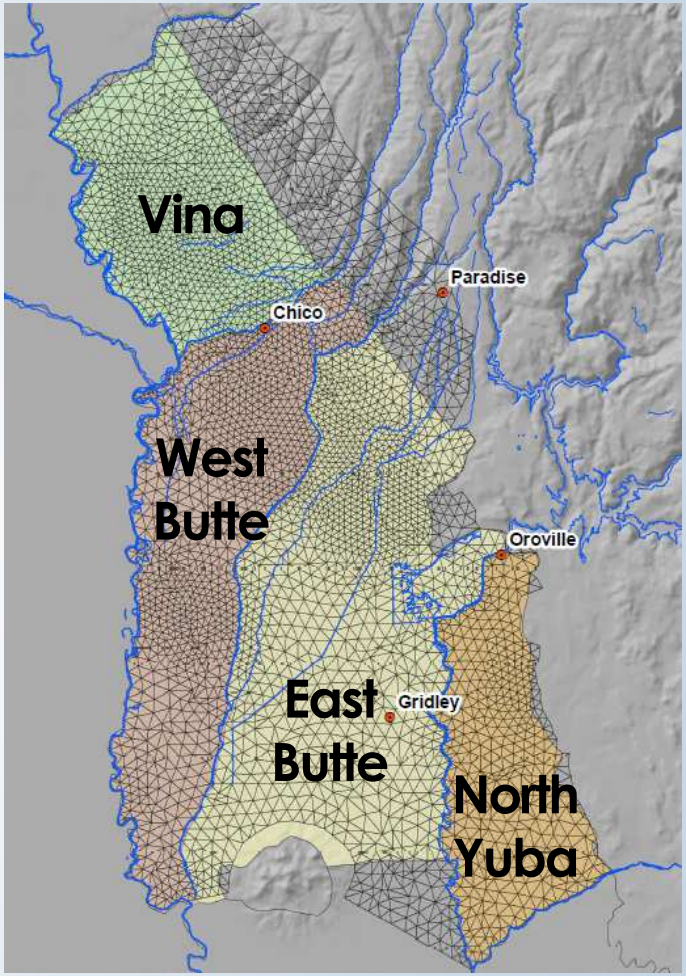
- Evaluate most current version of available models at time of GSP development: C2VSim, CVHM, SVSim (?)
- Compare to local surface layer models or water budget data to select model. Do not mix output from groundwater model with other local water budget sources.
- Over time, work with agencies to incorporate local knowledge/data into the selected regional groundwater model
- When evaluating a groundwater model, consider representation of:
  - Crop acreage
  - Irrigation practices
  - Surface water supplies and diversions
  - Rivers and streams (does it include ones the GSA considers important?)
  - Subsurface flows from outside the subbasin boundaries (eastern or western foothills)

Recommendations for DWR and USGS

- **Important opportunity to provide specific recommendations for technical assistance to GSAs**
- Develop tools and guidance to **ease comparison of models** (inputs like crop data, and outputs of water budget components)
- Process to **incorporate local data** into regional tools
- Provide guidance on use of these tools to address the six Undesirable Results defined by SGMA
- Report includes other specific technical assistance needs (e.g., methods for developing water budgets where boundaries align with streams)

Role of Local Models

- Valuable for detailed local analysis to evaluate management actions (e.g., recharge project)
- Feed data upward into regional models
- Differing estimates of interbasin flows may result in the initial GSPs but should tell a similar story
- Differences in part reflect the uncertainty in the modeled systems
- Overtime, regional tools will more closely reflect local data/knowledge and interbasin flow estimates should become more similar.



Butte Basin Groundwater Model

Perspectives on Models

- Expect a long term commitment- model updates are motivated by desire to better understand the system to support more effective management
- Models are more reliable in characterizing relative changes rather than predicting the absolute conditions resulting from a scenario
- Different models will not perfectly agree
- Acknowledge that there is no "right model"
- Importance of Adaptive Management- uncertainty inherent in models needs to be accounted for when making decisions based on their results

"All models are wrong; some are useful" – George Box

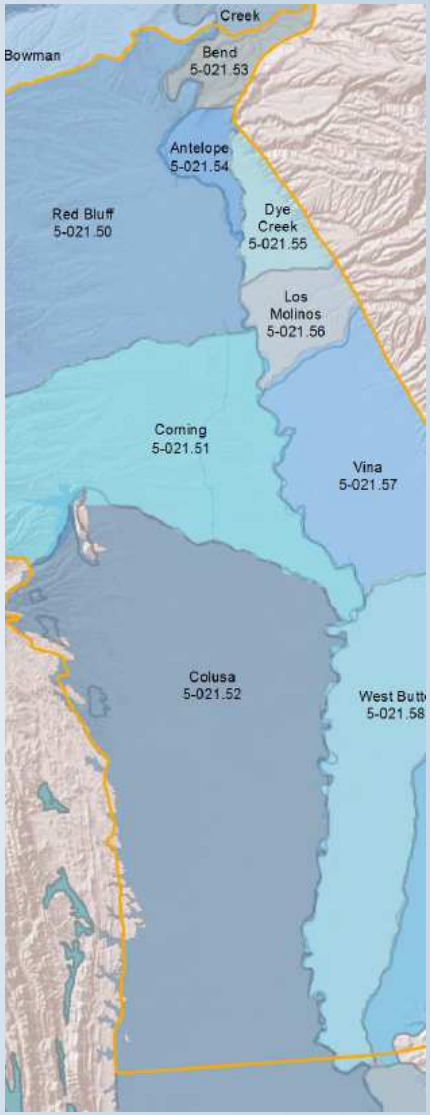
Conclusions

- An integrated gw-sw model should be used for water budget and GSP development by GSAs in the Northern Sacramento Valley (and Central Valley as a whole).
- Tools exist, but locals need to evaluate them for their specific area/subbasin
  - Include as task in upcoming grant proposal?
- Existing tools are a valuable starting point, but long term commitment is needed by GSAs and DWR/USGS to make them better for management under SGMA
- Need DWR/USGS to provide tools and guidance to make these models more easily comparable

Acknowledgements

- Water Foundation, an initiative of the Resources Legacy Fund, for their generous support
- Technical Collaborators
- RMC, a Woodard & Curran Company

Discussion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Bowman
Bend
5-021.53
Antelope
5-021.54
Red Bluff
5-021.50
Dye
Creek
5-021.55
Los
Molinos
5-021.56
Corning
5-021.51
Vina
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Colusa
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West Butte
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