

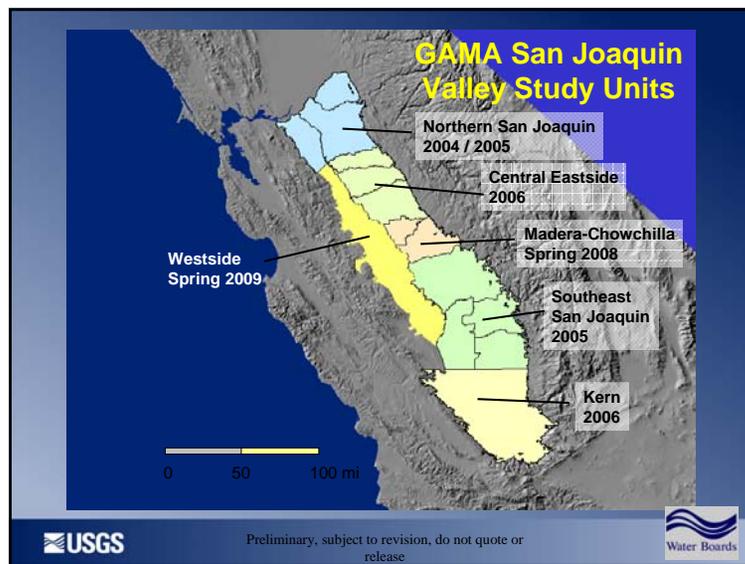
## Ongoing and Proposed USGS/GAMA Studies, & Thoughts Toward Understanding and Managing Groundwater Salinity in San Joaquin Valley

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## Topics

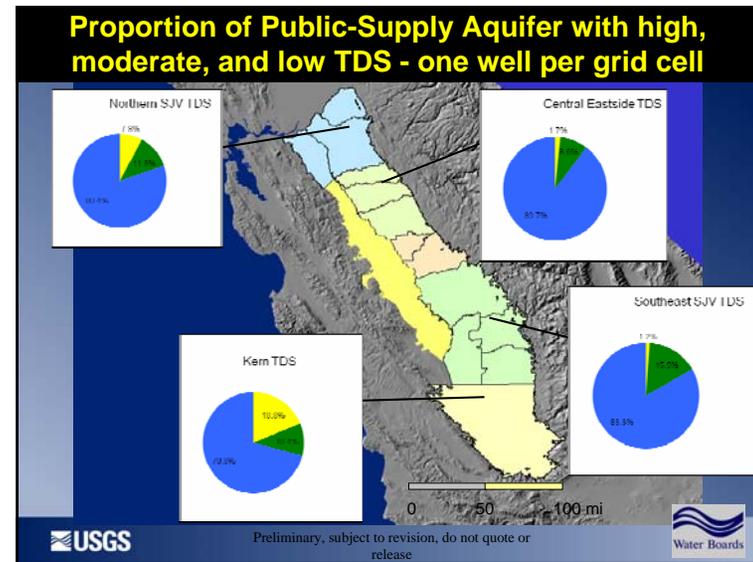
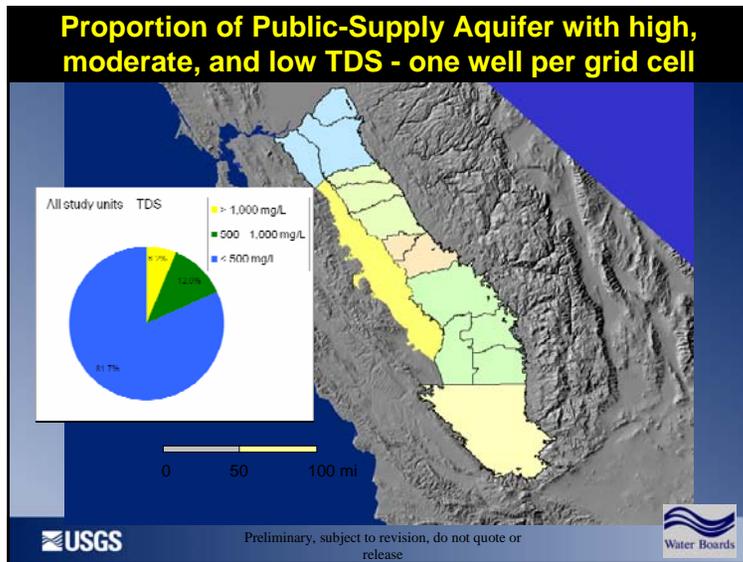
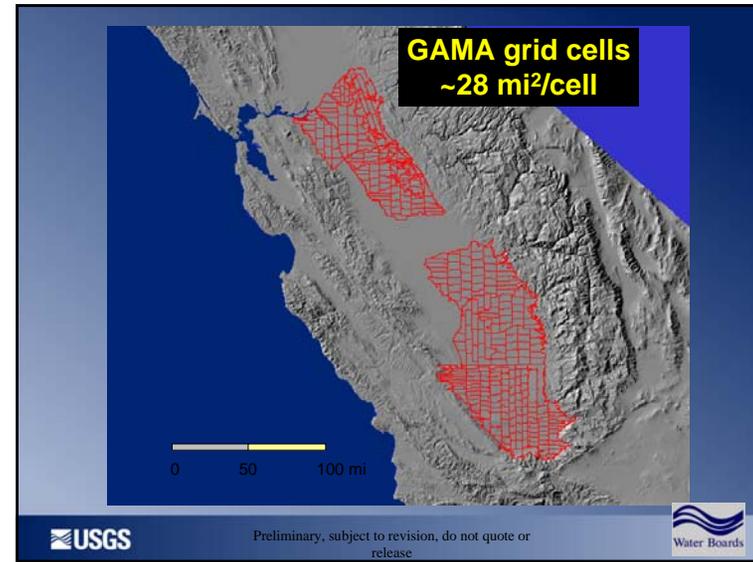
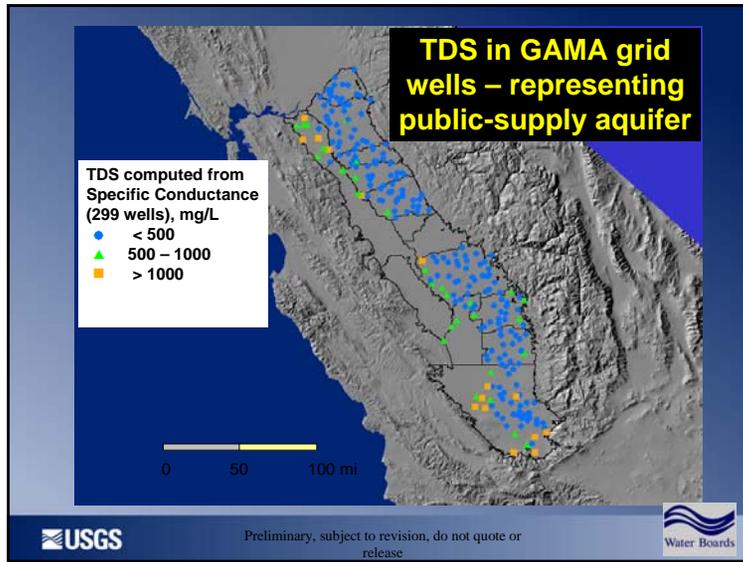
- USGS-GAMA characterization of groundwater salinity in public-supply aquifers
- USGS proposal to Salinity Policy Group for characterization of salinity in shallow aquifers
- Discussion of next steps toward understanding & managing salinity – modeling considerations



## SJV GAMA Analytes

Fast Schedule	Intermediate Schedule	Slow Schedule
Dissolved oxygen, specific conductance, temperature, pH	FAST SCHEDULE	FAST SCHEDULE
Volatile Organic Compounds	Alkalinity	INTERMEDIATE SCHEDULE
Pesticides and degradates	Nutrients	Gasoline additives
Perchlorate	Nitrogen and oxygen isotopes of nitrate	NDMA and 123-TCP
Noble gases & tritium	Dissolved gases (nitrogen, argon)	Polar pesticides and degradates
Stable isotopes of water	Major, minor, and trace elements	Radon-222
Pharmaceuticals	Chromium speciation	Radium isotopes
Used for determining occurrence and distribution of TDS Useful for understanding processes affecting TDS	Arsenic and iron speciation	Gross alpha and beta radiation
	Uranium isotopes	Microbial constituents
	Sulfur and oxygen isotopes of sulfate	Low-level VOCs (chlorofluorocarbons)
	Carbon isotopes	
	Boron and strontium isotopes	
	Dissolved organic carbon	
	Tritium	

USGS Water Boards



## Shallow Aquifer TDS Mapping

- Similar approaches to those used by GAMA for the public-supply aquifer can be used in the shallow aquifer zone
- Data sources:
  - USGS NWIS database
  - USEPA STORET database
  - Shallow wells sampled by USGS-GAMA
  - Other data collected locally (Irrigation Districts, etc.)?
- Other data useful for source analysis (GIS)
  - Saline soils
  - Depth to bottom of freshwater
  - Depth to water
  - Areas of evaporative discharge from groundwater
  - ET rates



## Approaches for analyzing data using the existing grid cell network

- Grid-based approach:
  - Spatially distributed, randomized grid network:
  - Equal area grid cells (~28 sq. mi.)
  - One well per grid-cell
  - Can compute confidence limits on estimates
- Spatially-weighted approach:
  - Data from many wells per cell included
  - Compute proportion of wells above specified thresholds for each constituent in each cell
  - Compute average proportion above threshold for all cells
  - Provides a useful comparison to grid-based approach

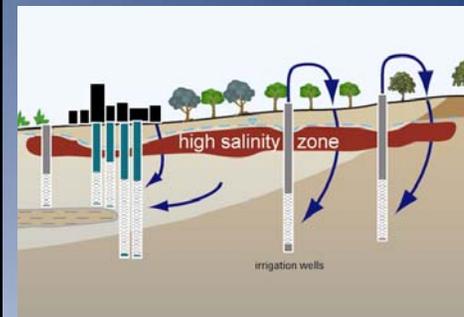


## Proposed products and estimated cost

- Products:
  - Maps of salinity in the shallow aquifer system, SJ Valley
  - Maps of ancillary factors related to salinity
  - A range of statistical analyses including spatially weighted proportions of the shallow aquifer having high, moderate, and low salinity values
  - A published report available online to the public
- The cost would be about \$200K
- Time required – about 1 year to presentation of results; 2 years to published report



## Understanding past & future changes in salinity



### Key questions:

- When will salinity front arrive at production wells?
- How high will concentrations get?
- How long will high concentrations last?



**Simulation can be used to help answer these key questions, and to test the effectiveness of management actions.**

Important aspects of models for these purposes:

1. Heterogeneity (variability) of aquifer materials strongly controls the duration and magnitude of solute concentrations [see movie]



## Important aspects of models continued

2. Important to consider the effects of scale



**Current USGS models include:**

- Regional
  - Central Valley
- Sub-regional
  - Modesto area
  - Grasslands
- Local
  - City Modesto
  - Merced River

## USGS Ground-Water Models

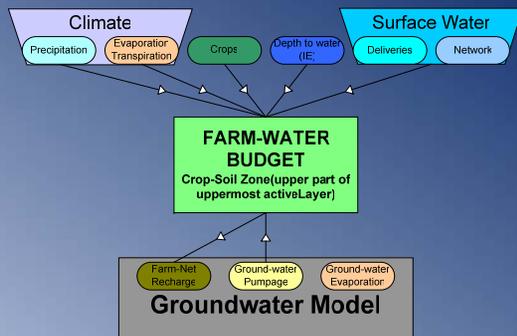


## Important aspects of models continued

3. Irrigated agriculture is a key distributed source of salinity → important to simulate associated processes



## The FARM Process allows realistic simulation of irrigated agriculture within MODFLOW



## The FARM Process does not currently track solutes

Proposed enhancements to the FARM Process, pending funding, are to:

- Simulate changing solute concentration in the root zone by tracking loads from irrigation, precipitation, and groundwater; and
- Salinity-dependent infiltration and transpiratory uptake

These enhancements will allow the direct simulation of long-term effects of various historical and future agricultural practices on the salinity of the root zone and underlying ground water.

## Topic for future discussion

Appropriate scale/resolution & degree of heterogeneity for addressing key questions

conceptual  realistic

- |                  |                   |
|------------------|-------------------|
| • regional scale | • local scale     |
| • low resolution | • high resolution |
| • homogeneous    | • heterogeneous   |

