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Basin Scale Groundwater Quality Management Modeling: Methods to Upscale the Advection Dispersion Equation

Background

In some groundwater basins in California and around the world, shallow regional groundwater quality shows a decling trend in water quality, mostly notably from non-point source pollutants like salts and nitrates. These trends coincide with the regional changes in water and land use. The introduction of nonpoint source pollutants from imported irrigation water and fertilizers is compounded by excessive groundwater withdrawl, which disconnects ground and surface water bodies, leaving dissolved solids no exit. Thus they remain in the basin and migrate into deeper groundwater.

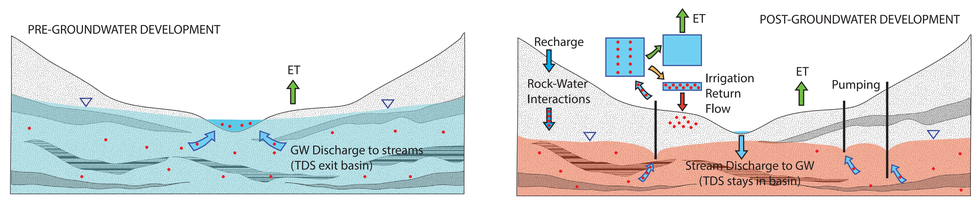
If deep groundwater quality is vulnerable to nonpoint source pollutants, the questions that remain include:

Q1: What are the timescales of deep groundwater contaminantion from non-point source pollutants?
Q2: What water management practices will slow or reverse this?

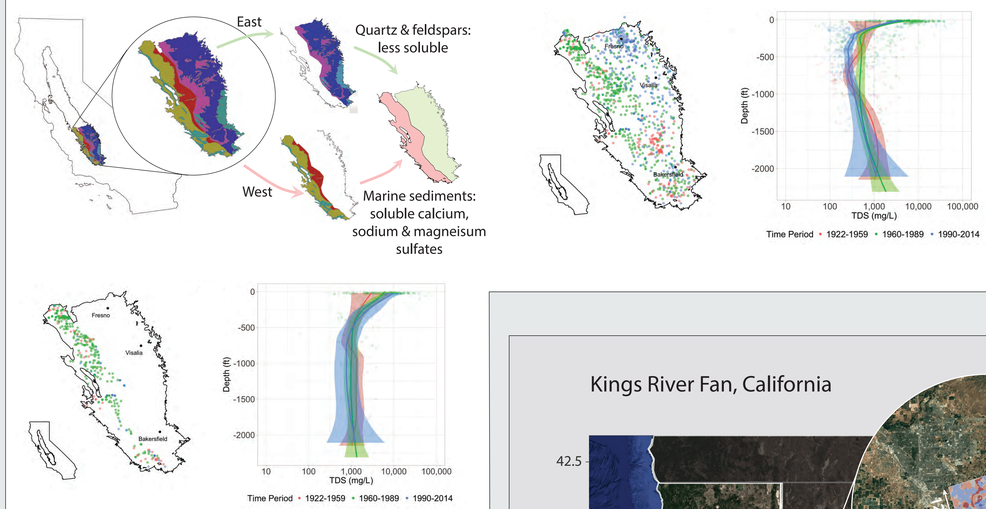
Simulating basin-scale water quality, and management options to address declines in groundwater quality are more important than ever.

Groundwater flow modeling is simplified by upscaled K' fields, but the transport of contaminants is not so easily upscaled. Previous studies have shown that geology exerts a powerful control on transport processes. Therefore, we seek to develop new methods that upscale 3D geologically heterogeneous domains to 2D heterogeneous domains that reproduce the same breakthrough in 2 dimensions that we observe in 3 dimensions. These models will be the first ever basin-scale transport groundwater quality management models.

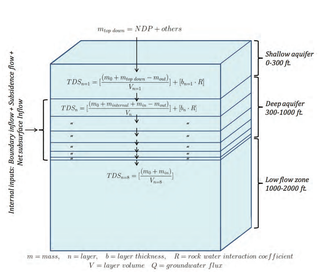
Regional Groundwater Salinization

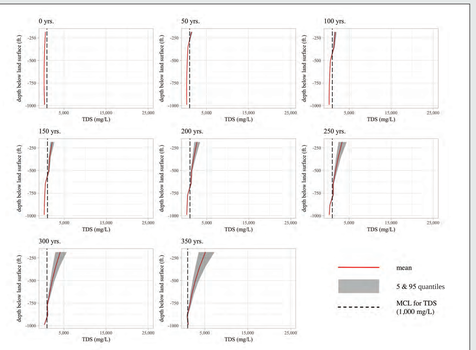


Regional Groundwater Quality

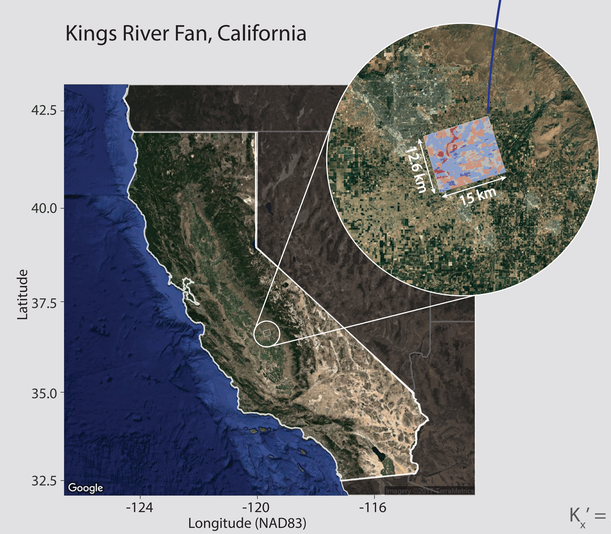


1D Mixing Models

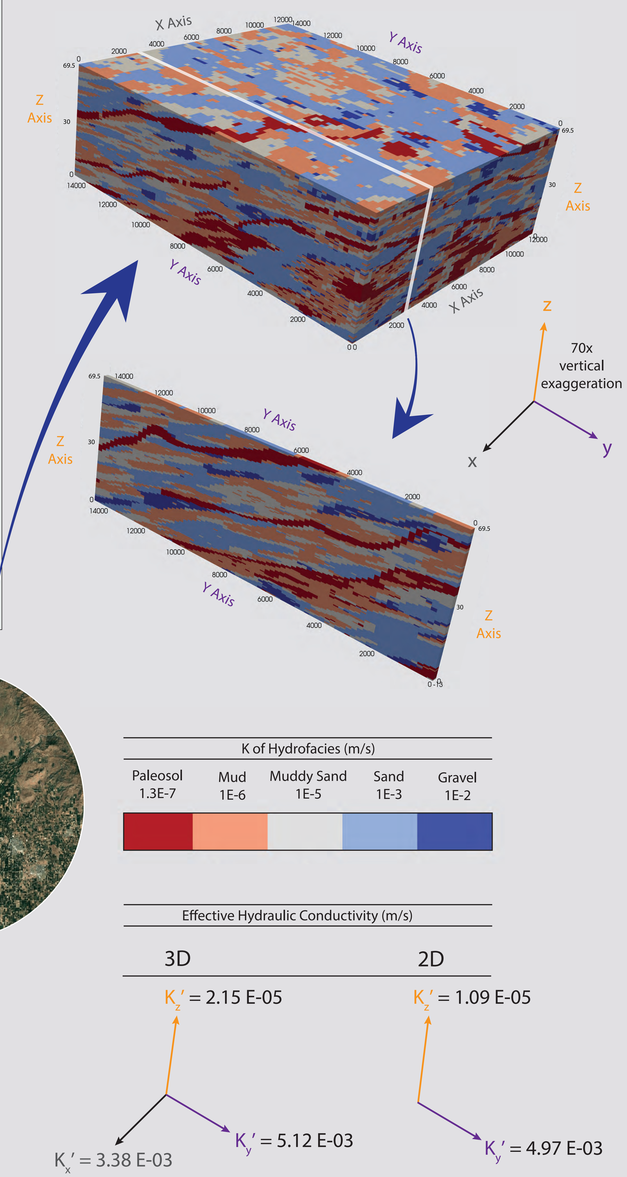




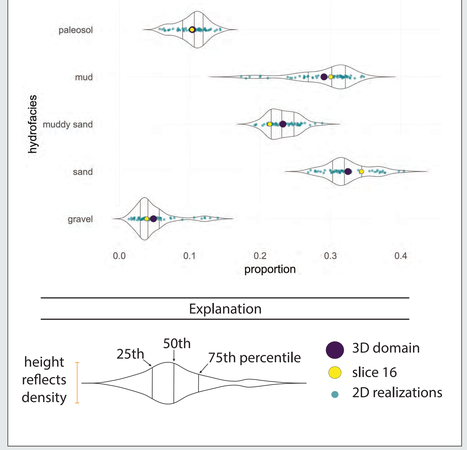
Kings River Fan, California



Geostatistical Model



2D Realizations



Discussion

- Shallow groundwater quality is on the decline in irrigated basins in California, and likely wherever closed basin conditions prevail worldwide.

- The shallow groundwater quality issues of today are bound to become the deep groundwater quality issues of tomorrow.

- Non-point source contaminant transport at the basin-scale (tens of kilometers) should consider the role of geologic heterogeneity in transport processes.

- Regional groundwater quality management models will benefit from upscaled K fields for tractability and computational ease.

- Methods to impart the connectivity observed in 3D models to 2D models remain undeveloped.

- Climate change, exploitation of groundwater resources, and the expansion of population and agriculture require clean and sustainable sources of water.

- The development of regional-scale groundwater quality management models will enable scientists and managers to simulate contamination scenarios, and decide how to best approach sustainable groundwater quality management.

Acknowledgments

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