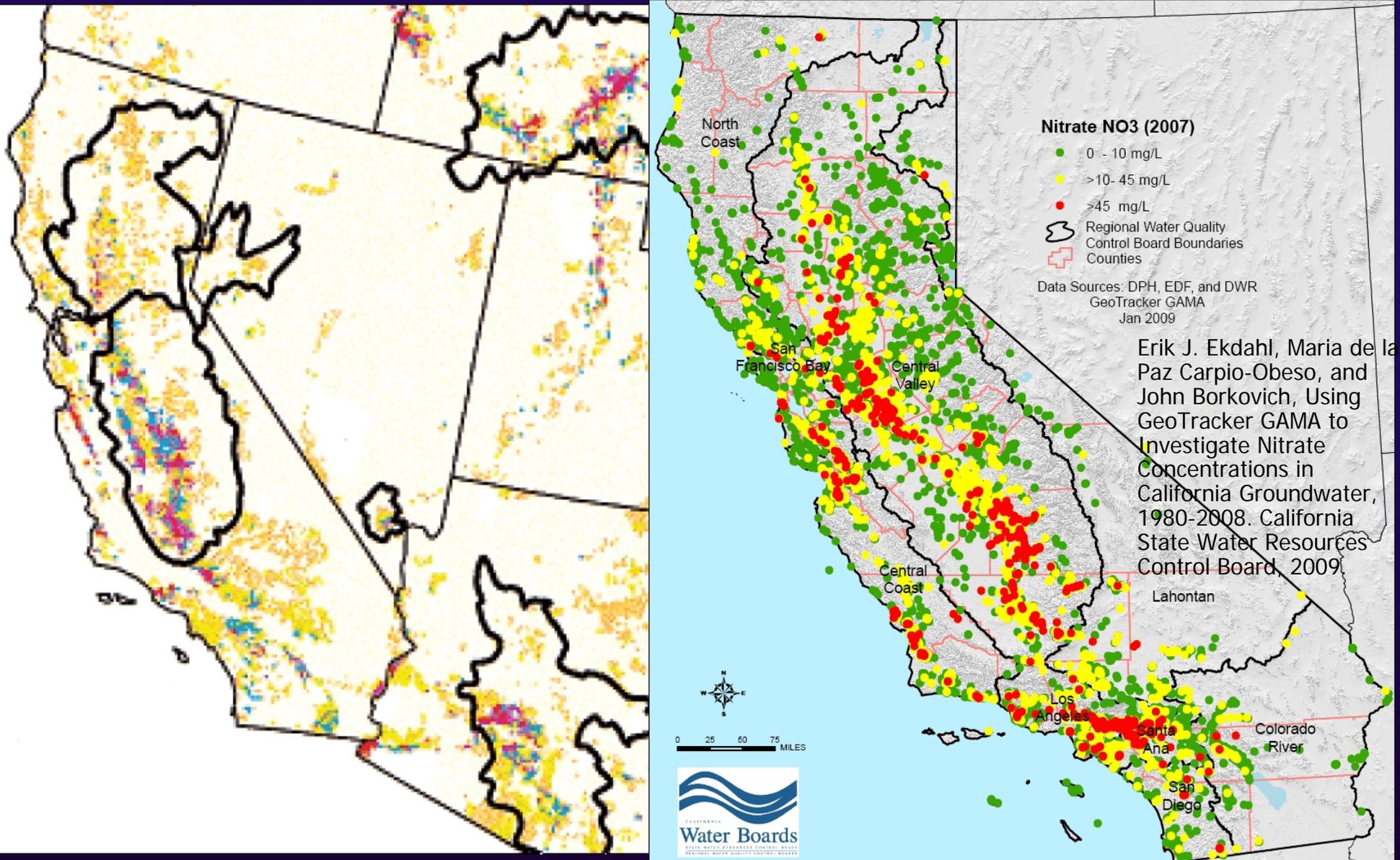
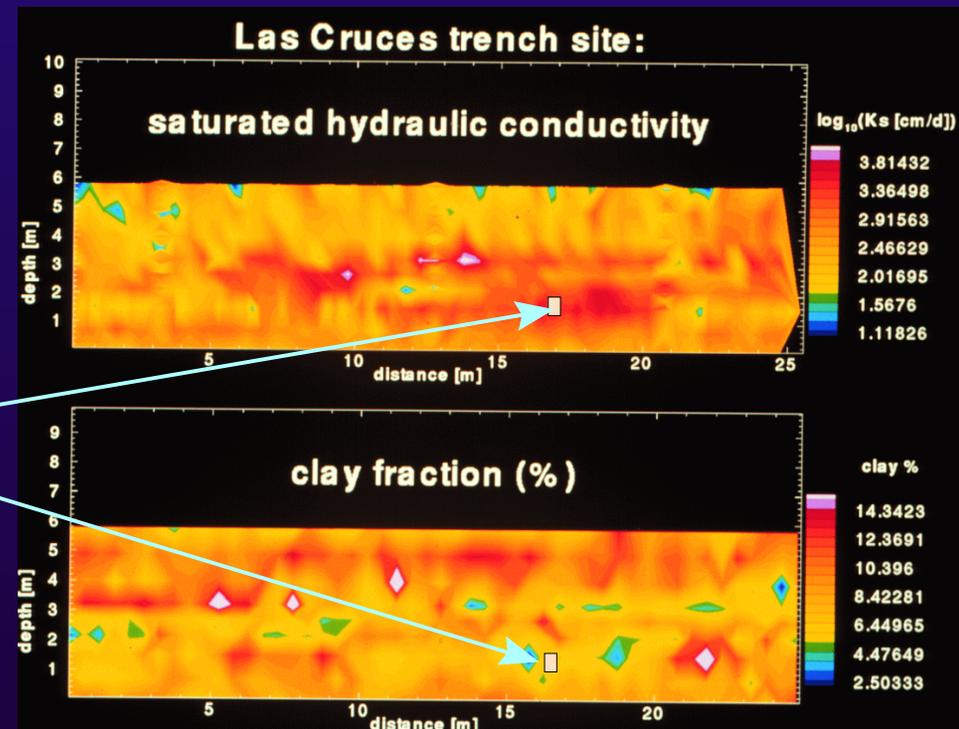
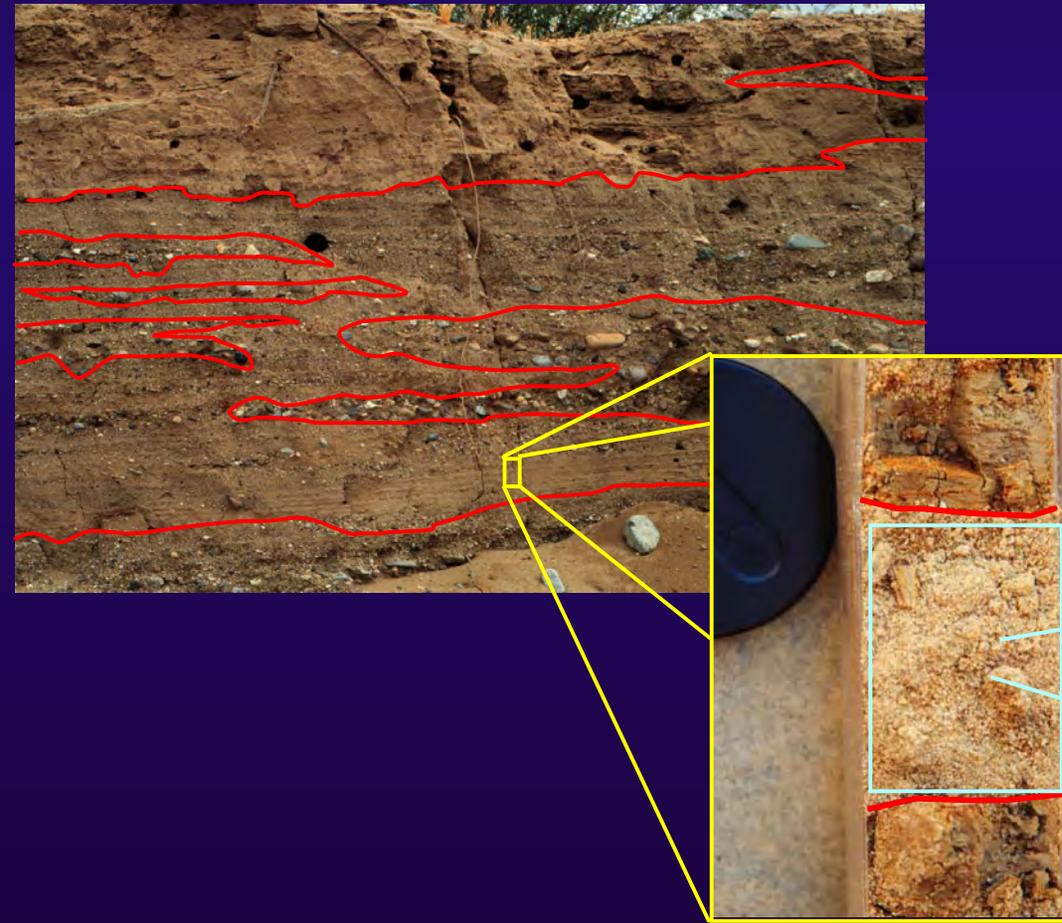


Statistical Methods

Nolan et al., 2002: U.S. Nitrate Vulnerability Map



Incorporating Heterogeneity

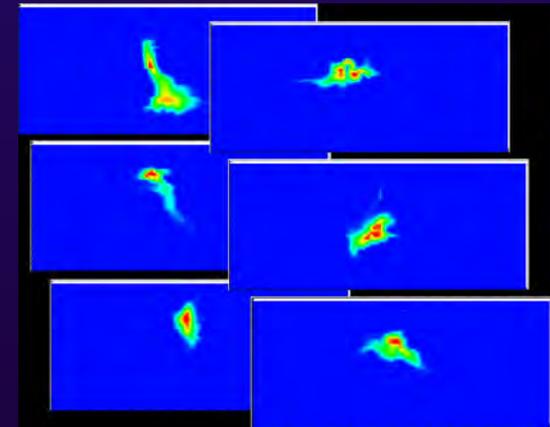
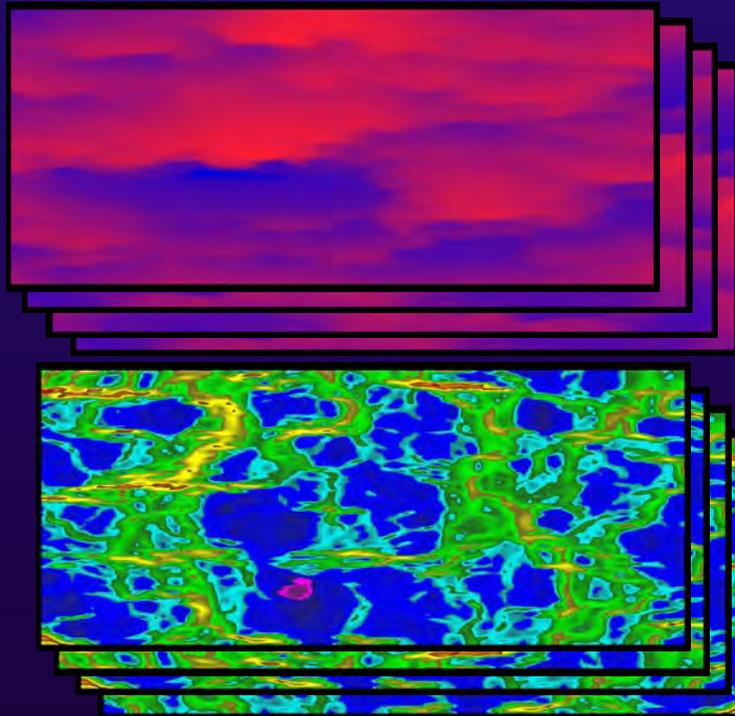
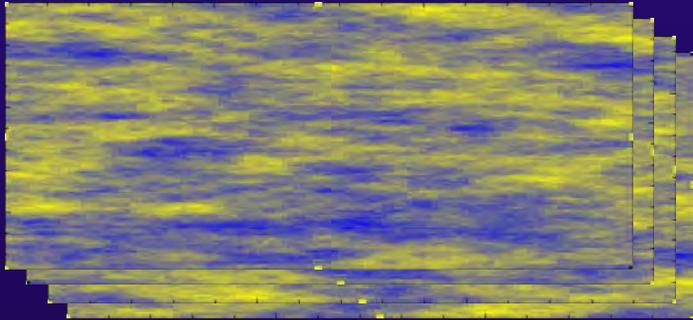


... Uncertainty, Statistics, and Modeling

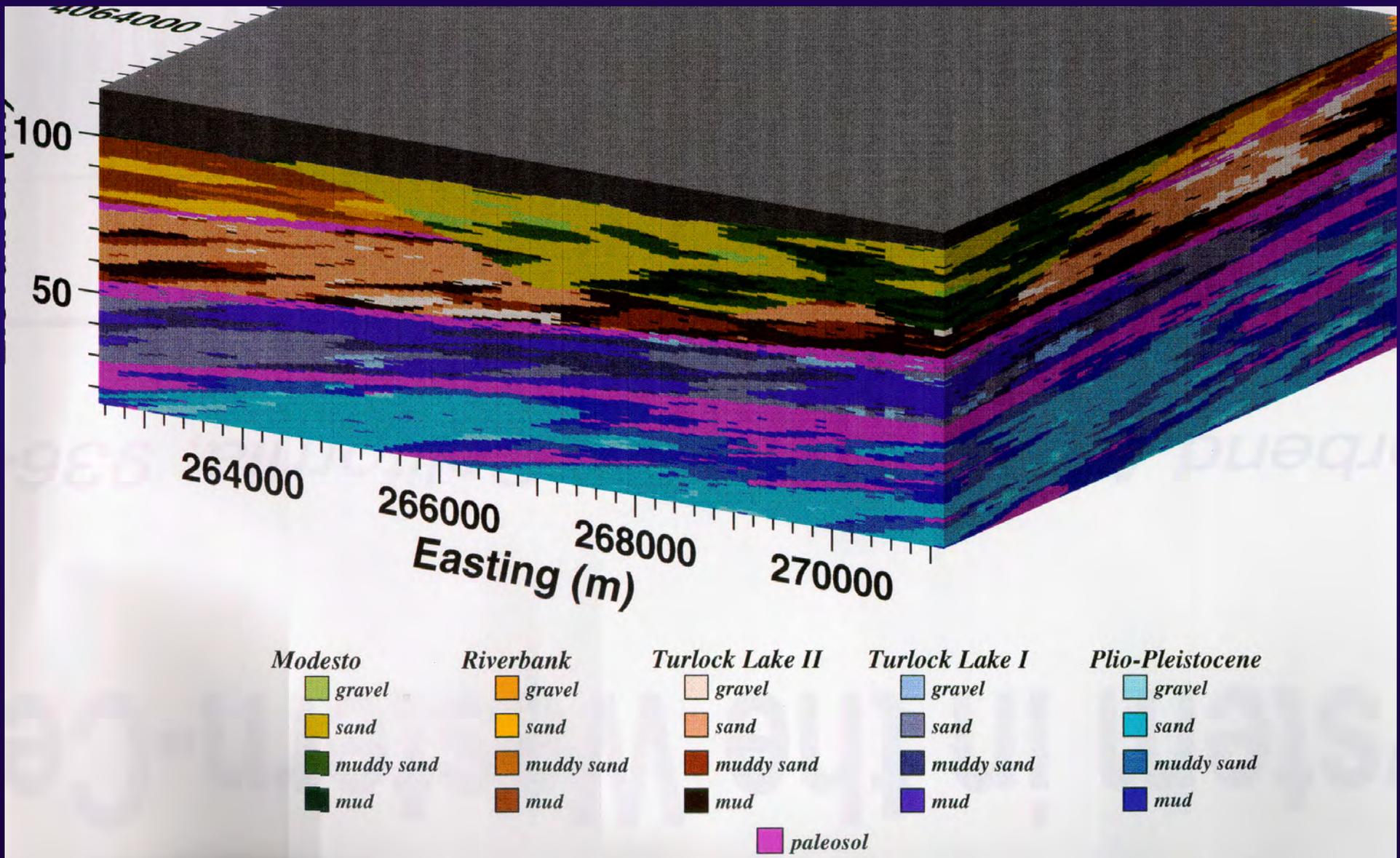
Random Field
Generator

MODFLOW

MT3D



Confined or Unconfined?



Choosing the Best Method

- Objectives of the assessment
- Availability of data
- Availability of funding
- Risk of misguided land management / future lawsuit

Choosing the Best Method

- **Index-and-Overlay methods:**
 - ▶ Well-suited for landuse planners
 - ▶ Most input data commonly available
 - ▶ Procedure is a “black-box” prescription
 - ▶ Interpretation requires professional support
- **Process Modeling:**
 - ▶ Input data intensive
 - ▶ Appropriate where other objectives are linked to modeling requirements
- **Statistical Methods:**
 - ▶ Ideal where existing tracers/contamination can be used to develop statistical relationships
 - ▶ When application areas are similar to those for which statistical models are developed

Accounting for Uncertainty

- Implicit only in the statistical methods
- For other methods:
 - ▶ expert assessment
 - ▶ first order error analysis

After the Assessment: Verification and Post-Audit

- Verification: part of the vulnerability assessment (confidence building)
- Post-Audit: years after the assessment to re-evaluate planning tool

Limitations & Role in GW Mgmt.

National Research Council, 1993

- All groundwater is vulnerable
- Uncertainty is inherent in all vulnerability assessments
- The obvious may be obscured and the subtle indistinguishable

