Techniques to assess human and climate impacts on groundwater - the High Plains aquifer perspective

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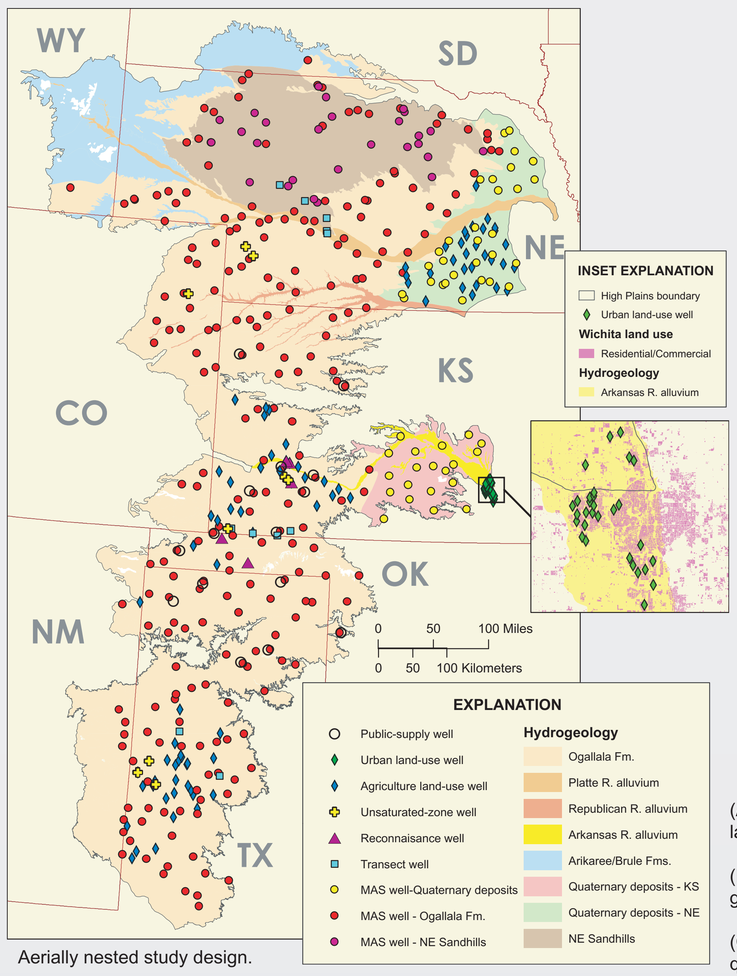
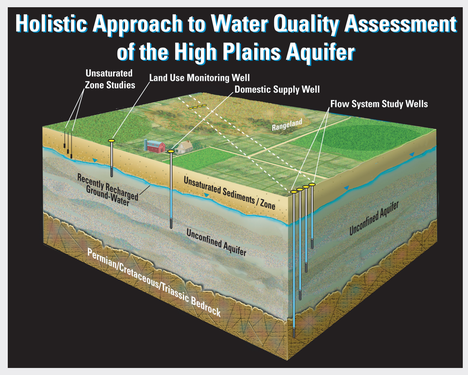
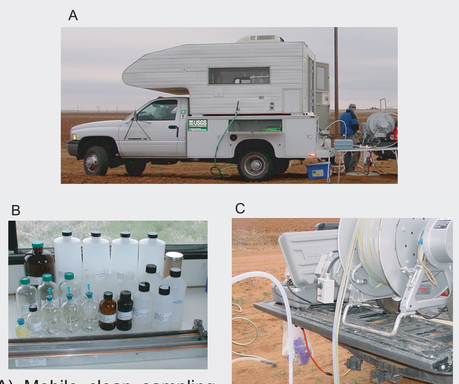
Regional Groundwater-Quality Assessment - Nested Study Design



Aerially nested study design.



Vertically nested study design.



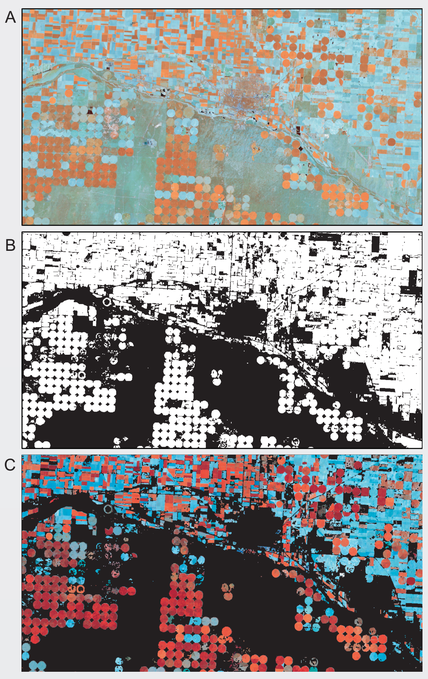
(A) Mobile clean sampling laboratory.

(B) Wide range of sampled groundwater constituents.

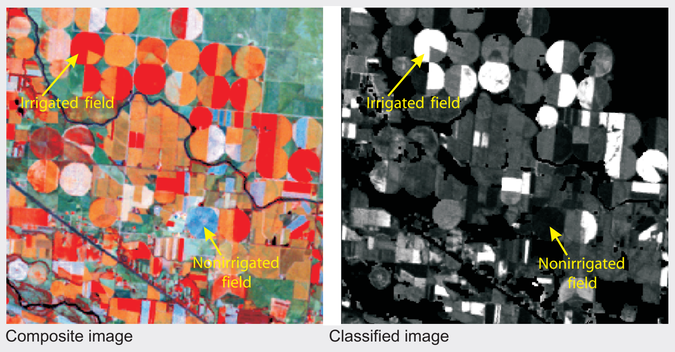
(C) Sampling groundwater-quality of monitoring well.

Remote Sensing - Land Use / Land Cover Identification

Irrigated, non-irrigated, and rangeland.

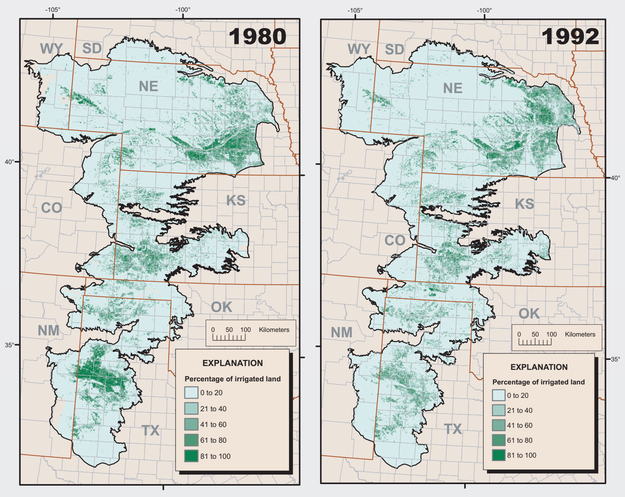


Example of masked satellite image:
A - Original composite band image,
B - Agricultural areas designated by NLCD,
C - Resulting image to be processed.



Composite image Classified image

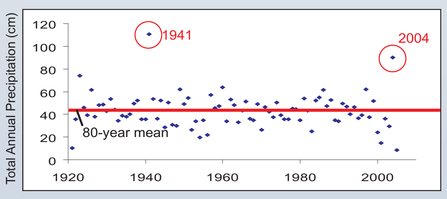
Example of a composite and resulting classification image. The white/gray areas represent irrigated land and the black areas represent nonirrigated land.



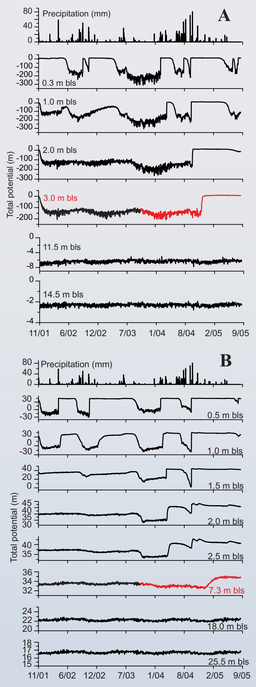
Comparison of irrigated density between 1980 and 1992.

Groundwater and Unsaturated Zone Response to Natural Climate Variability

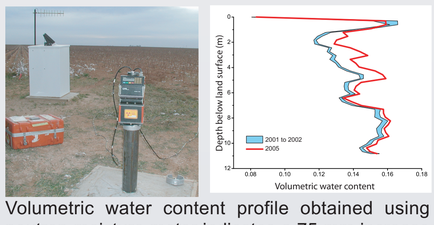
Weather station located at NHP rangeland unsaturated zone monitoring site.



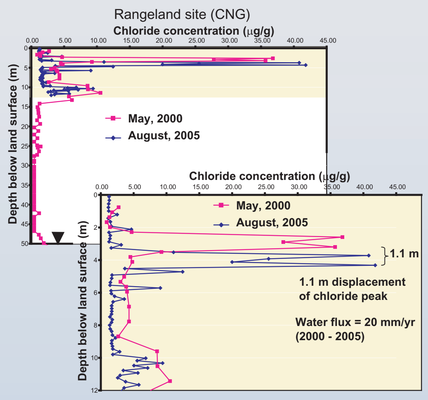
Total annual precipitation at SHP rangeland unsaturated zone monitoring site



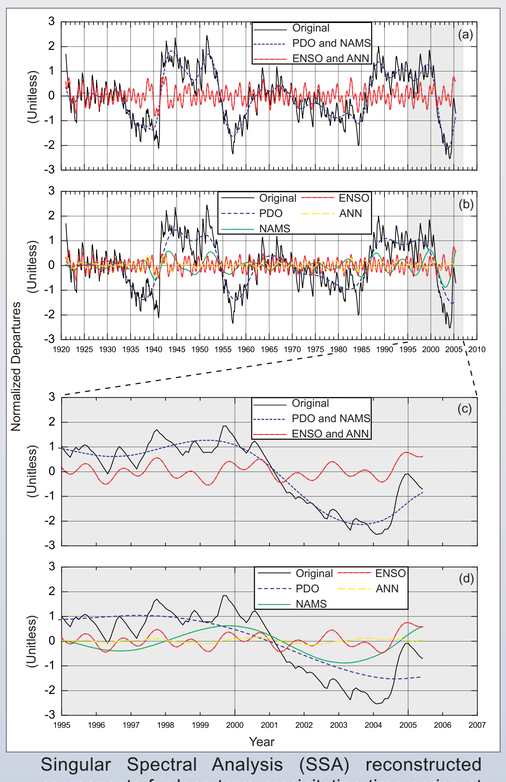
Daily precipitation and total potential profiles indicate deep percolation events beneath SHP unsaturated zone sites at (A) rangeland setting, and (B) irrigated agricultural setting.



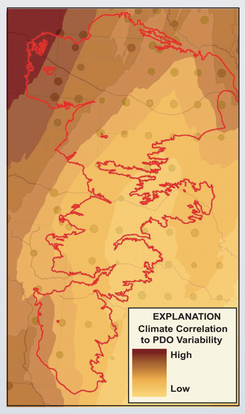
Volumetric water content profile obtained using neutron moisture meter indicates a 75-mm increase in water storage in 2005 compared to 2001-2002 range in volumetric water content.



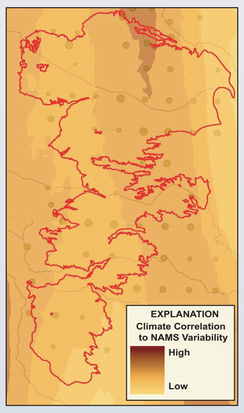
Chloride profiles indicate a 1.1 m downward displacement. Water flux for 2000 to 2005 is 20 mm/yr; long-term mean water flux is 5 mm/yr.



Singular Spectral Analysis (SSA) reconstructed components for long-term precipitation time series at SHP rangeland unsaturated zone monitoring site.

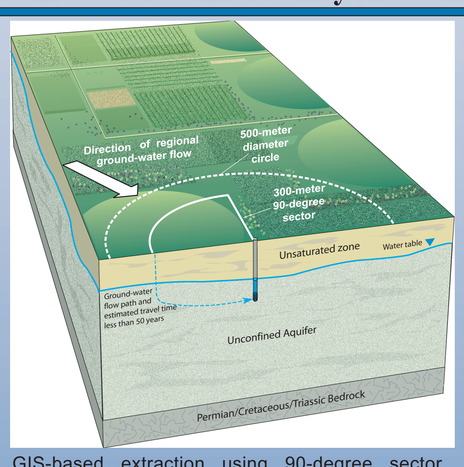


Contoured maximum periodicity for the Pacific Decadal Oscillation (PDO) (10-25 years) climate cycles by kriging precipitation and tree-ring indices.

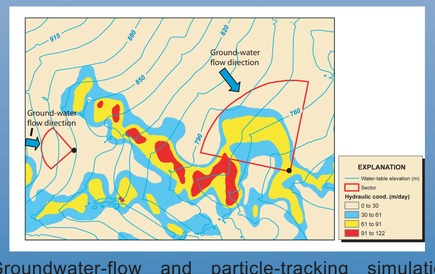


Contoured maximum periodicity for the North American Monsoonal System (NAMS) (7-10 years) climate cycles by kriging precipitation and tree-ring indices.

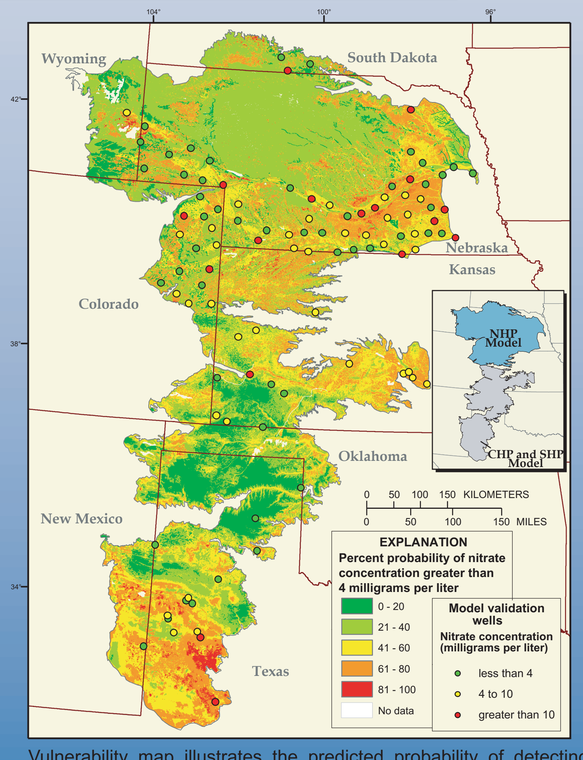
Groundwater-Vulnerability Assessment - Nonpoint Source Nitrate



GIS-based extraction using 90-degree sector contributing area as input for logistic regression based groundwater-vulnerability assessment.

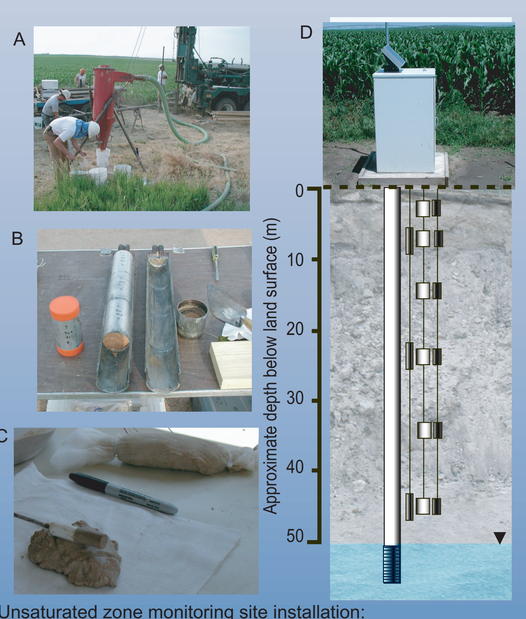


Groundwater-flow and particle-tracking simulations constrained contributing area, used during groundwater-vulnerability model calibration and map construction

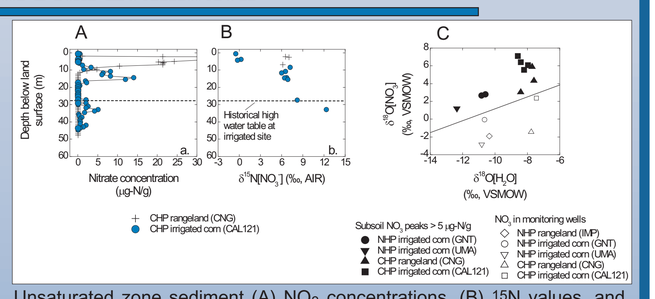


Vulnerability map illustrates the predicted probability of detecting nitrate > 4 mg/L in recently recharged groundwater (< 50 years). Nitrate concentrations from validation well network is shown.

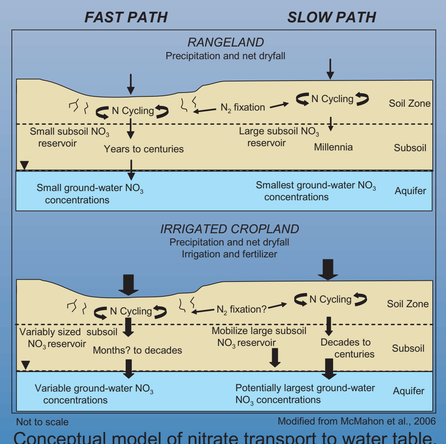
Unsaturated Zone Water and Chemical Flux Estimation



Unsaturated zone monitoring site installation:
A. Casing-advance, dry-drilling technology.
B. Collect cores for water content, chemical, and physical analyses.
C. Heat dissipation probe (HDP) preparation.
D. Final installation, includes HDP, lysimeters, gas sampling ports, monitoring well, weather stations, and remote data storage and transmission to office.



Unsaturated zone sediment (A) NO_3 concentrations, (B) ^{15}N values, and (C) $^{18}O[NO_3]$ and $^{18}O[H_2O]$ values.



Conceptual model of nitrate transport to water table.

Questions

For additional information, please visit our homepage at
http://co.water.usgs.gov/nawqa/hpgw/index.html

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Groundwater Resources Assessment under the Pressures of Humanity and Climate Change