



Probability of Detecting Atrazine and Elevated Concentrations of Nitrate in Colorado's Ground Water

USGS Water-Resources Investigations Report 02-4269

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TAKE HOME MESSAGE

- Probability models are a cost effective use of GW monitoring information because they extrapolate correlations made in areas of known GW quality to areas where no sampling has been performed.
- Probability models are more defensible than old vulnerability maps like DRASTIC because they quantify the actual probability of contamination.

AGENDA

- 1) Why we did the project.**
- 2) Data used in the probability models.**
- 3) Development of probability models.**
- 4) Verification of model effectiveness.**

PARTNERS

- Colorado Department of Public Health and Environment
- Colorado Department of Agriculture
- Colorado State University Cooperative Extension
- U.S. Environmental Protection Agency

STATE PESTICIDE MANAGEMENT PLAN (PMP)

- Proposed (1996) USEPA regulations require each state to develop a pesticide management plan for atrazine, alachlor, ~~cyanazine~~, metolachlor, simazine.
- Even though USEPA rule is not finalized, many states are developing a PMP as part of their ground-water protection strategy.

PURPOSE OF THIS PROJECT

- **Develop maps that show the predisposition of areas in Colorado to ground-water contamination by atrazine and nitrate.**
- **Provide a consistent, quantitative, statewide approach.**
- **Results not intended for making site-specific decisions.**
- **Provide map products that can be used as prioritization and educational tools by the Colorado PMP.**

DATA USED BY PROJECT

GROUND-WATER MONITORING DATA

Two sources of data

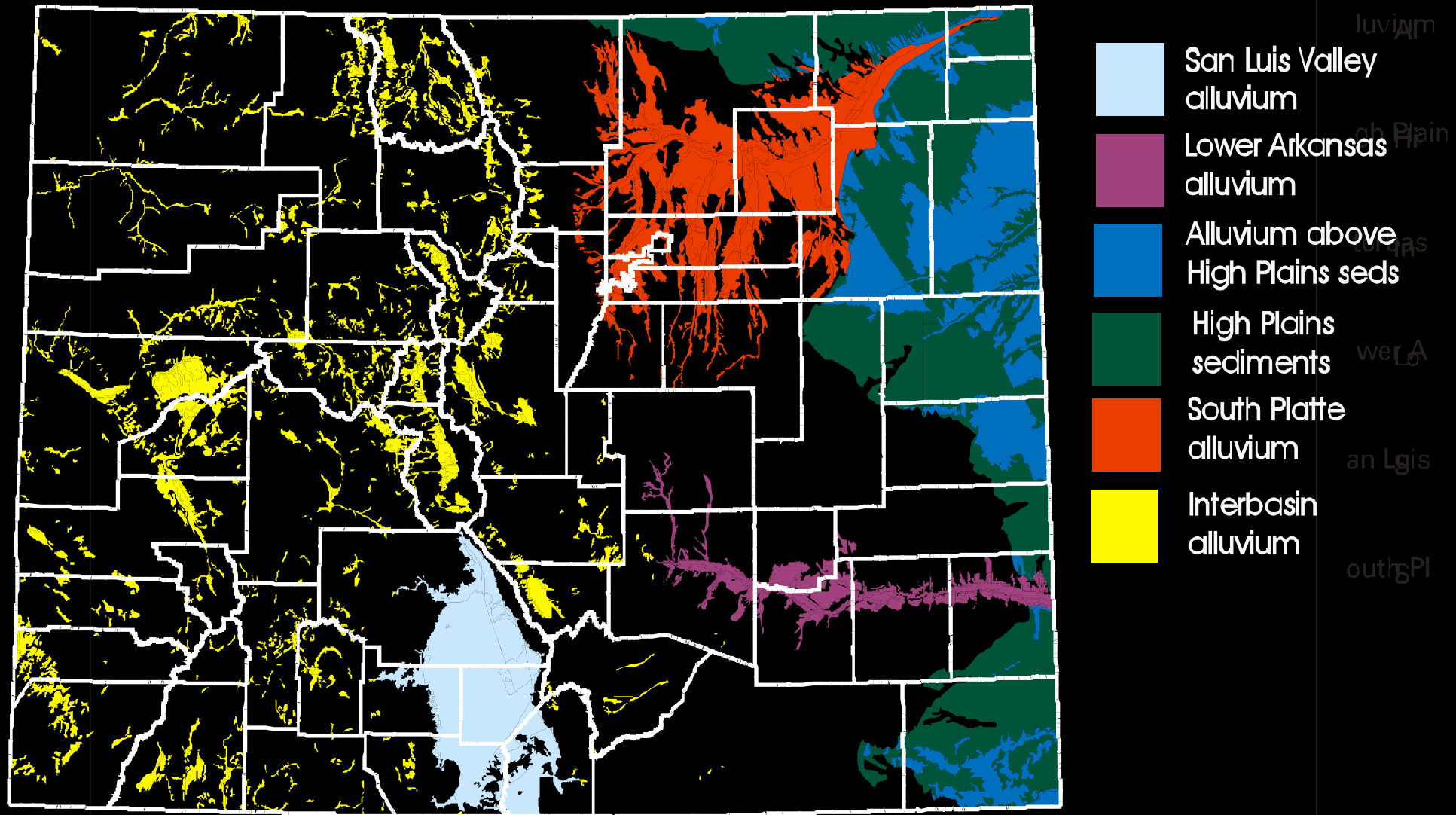
- Colorado Department of Health:
Atrazine MRL = 0.1 mg/L,
Nitrate MRL = 0.5 mg/L
- USGS:
Atrazine MRL = 0.001 mg/L,
Nitrate MRL = 0.05 mg/L

Colorado data used to calibrate the models,
USGS data used to verify the models.

GIS DATA

- Atrazine and Fertilizer Chemical Use
- Elevation
- Geology
- Hydrogeomorphic Regions
- Land Cover
- Precipitation
- Soils

HYDROGEOMORPHIC REGIONS



USGS National Land Cover Data (NLCD), Early 1990's.

- Forest
- Shrubland
- Low intensity residential
- High intensity residential
- Commercial and transportation
- Urban and recreational grass
- Pasture and hay
- Row Crops (irrigated)
- Small grains (dryland)
- Fallow lands

STATSGO SOIL CRITERIA EXAMINED

- Available water capacity
- Clay content
- Flood frequency
- Liquid limit
- Occurrence of hydric soils
- Organic matter content
- Permeability
- Soil hydrologic group
- Soil drainage
- Soil thickness
- Surface slope
- Soil erodibility

DEVELOPMENT OF PROBABILITY MODELS

LOGISTIC REGRESSION MODELS

- The models were developed through a painstaking process of incorporating a new variable, observing how the statistical strength of the model was affected, and then deciding to include or reject that variable.
- All possible combinations of independent variables were evaluated.

FOUR MODELS WERE CHOSEN

1. Atrazine probability, no atrazine use
2. Atrazine probability, with atrazine use
3. Nitrate probability, no fertilizer use
4. Nitrate probability, with fertilizer use

Chemical use estimates are only available for each county (large changes at county boundaries).

Which Variables Were Used in the Final Models?

	MODEL 1		MODEL 2		MODEL 3		MODEL 4
VARIABLE	ATRAZINE		ATRAZINE		NITRATE		NITRATE
	NO INPUT		W/INPUT		NO FERT		W/FERT
ATRAZINE USE			X				
ELEVATION							
FERTILIZER USE							X
GEOLOGY							
HYDROGEOMORPHIC REGION	X		X		X		X
LAND COVER	X		X		X		X
PRECIPITATION							
SOILS	X		X		X		X

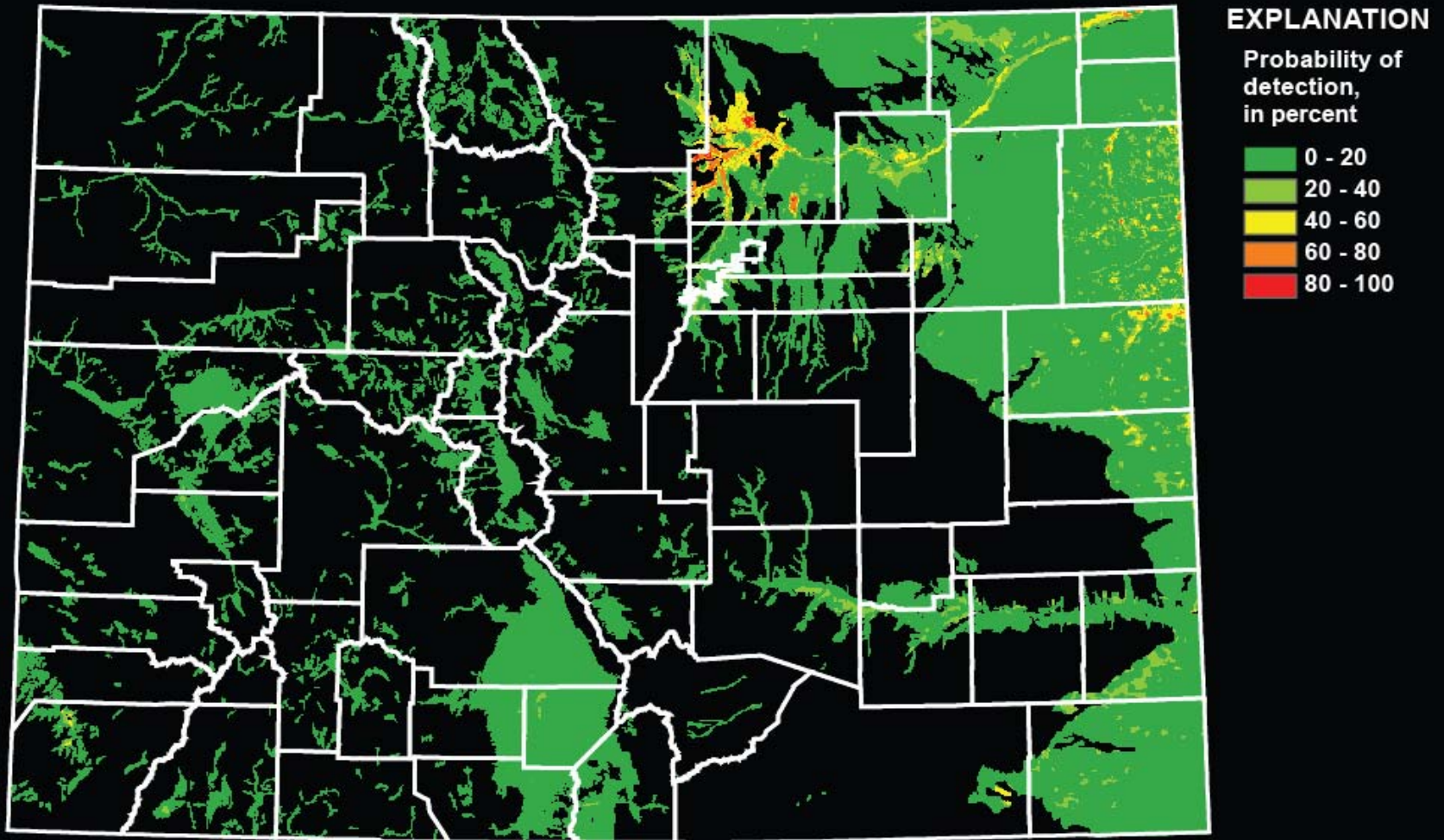
Soil Variables Used in the Final Models

VARIABLE	ATRAZINE		NITRATE
AVAILABLE WATER CAPACITY	+		+
CLAY CONTENT	-		-
SOIL ERODIBILITY			
ORGANIC MATTER	-		-
PERMEABILITY			
SOIL THICKNESS			
HYDROLOGIC GROUP			
DRAINAGE			
SOIL SLOPE			
LIQUID LIMIT			
HYDRIC CAPACITY	-		-

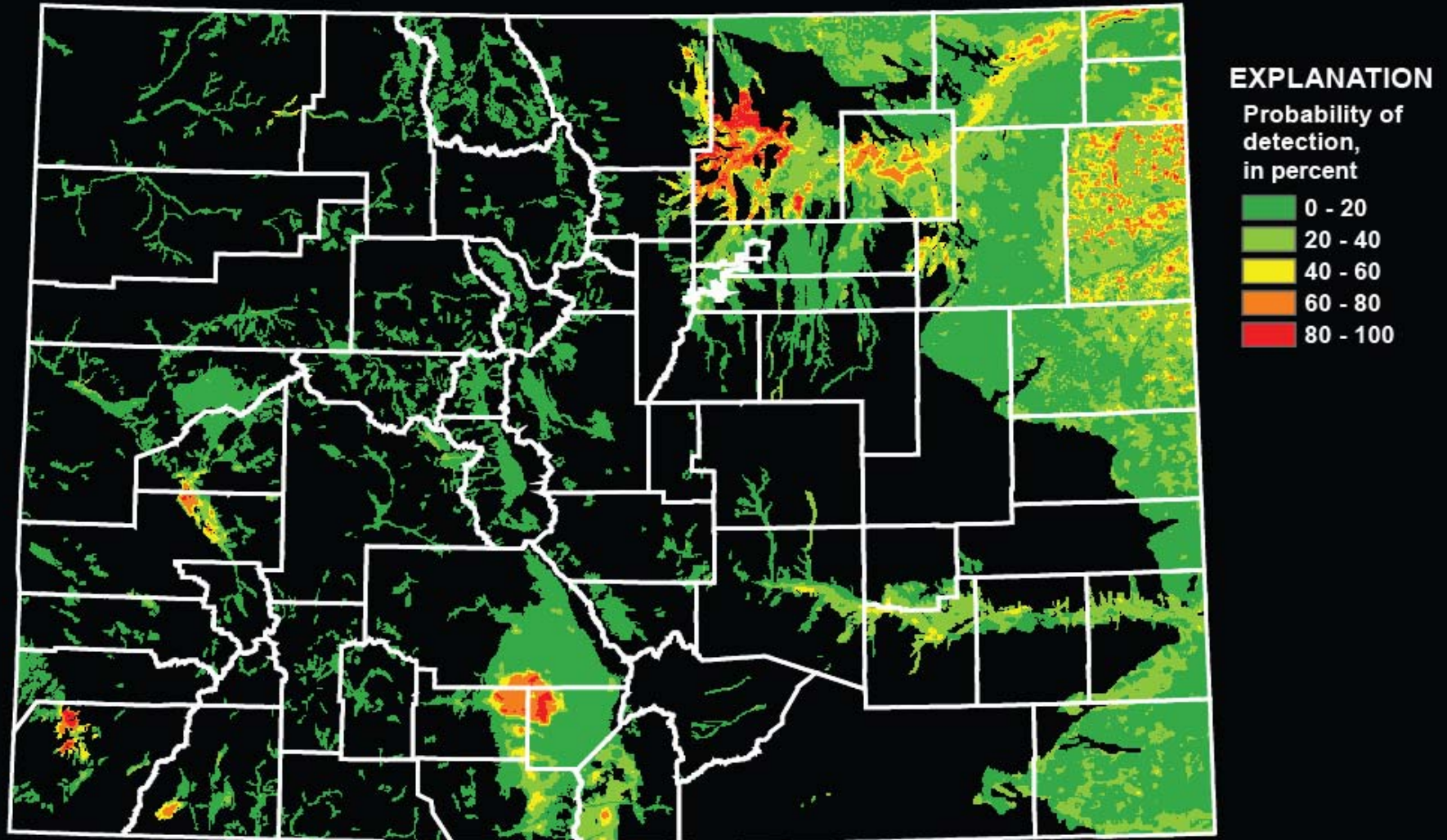
Land Cover Variables Used in the Final Models

VARIABLE	ATRAZINE		NITRATE
FOREST			
SHRUB			
LOW INTENSITY RESIDENTIAL			
HIGH INTENSITY RESIDENTIAL			
COMMERCIAL&TRANSPORTATION			
URBAN & RECREATIONAL GRASS			
PASTURE & HAY			
ROW CROPS (IRRIGATED)	+		+
SMALL GRAINS (DRYLAND)	-		
FALLOW			

PROBABILITY OF DETECTING ATRAZINE ABOVE 0.1 $\mu\text{g/L}$, ATRAZINE USE INCLUDED



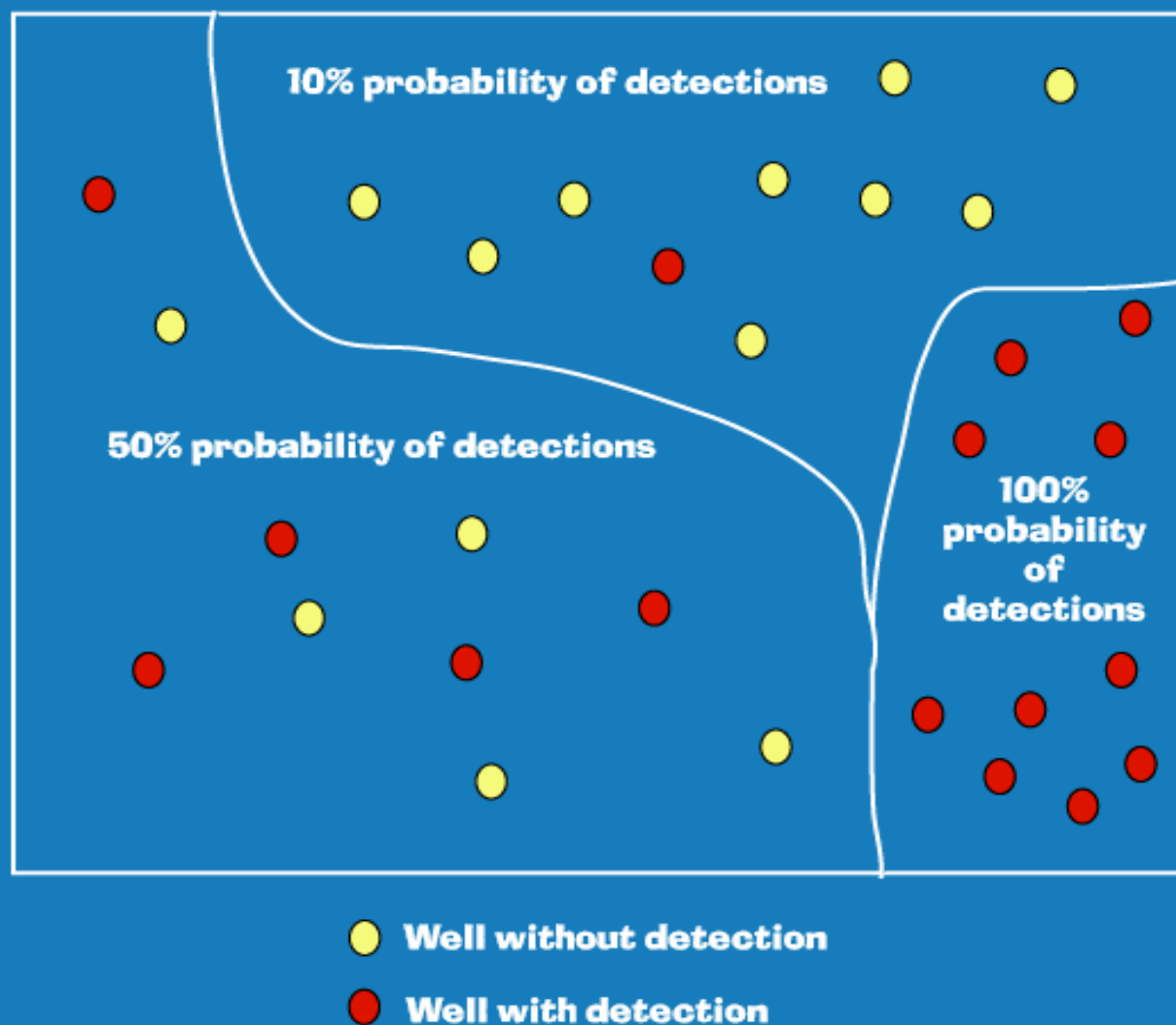
PROBABILITY OF DETECTING NITRATE ABOVE 5 mg/L, FERTILIZER USE INCLUDED



VERIFICATION OF MODEL RESULTS

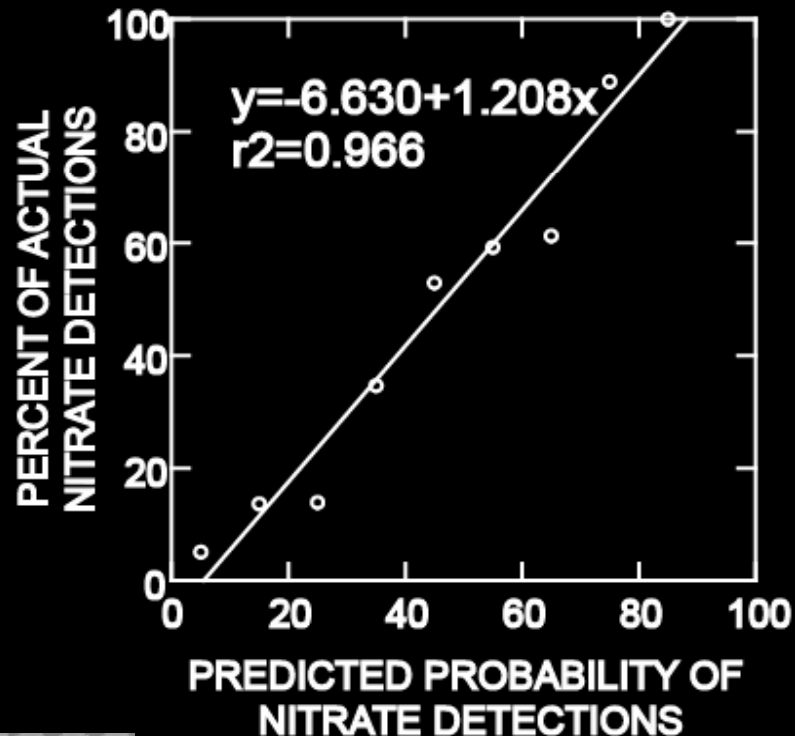
- The atrazine and nitrate models were calibrated using GW monitoring data collected by the State of Colorado.
- The effectiveness of the models was verified by comparing them to an independent data set collected by the USGS.

Probability map superimposed with ground-water monitoring data

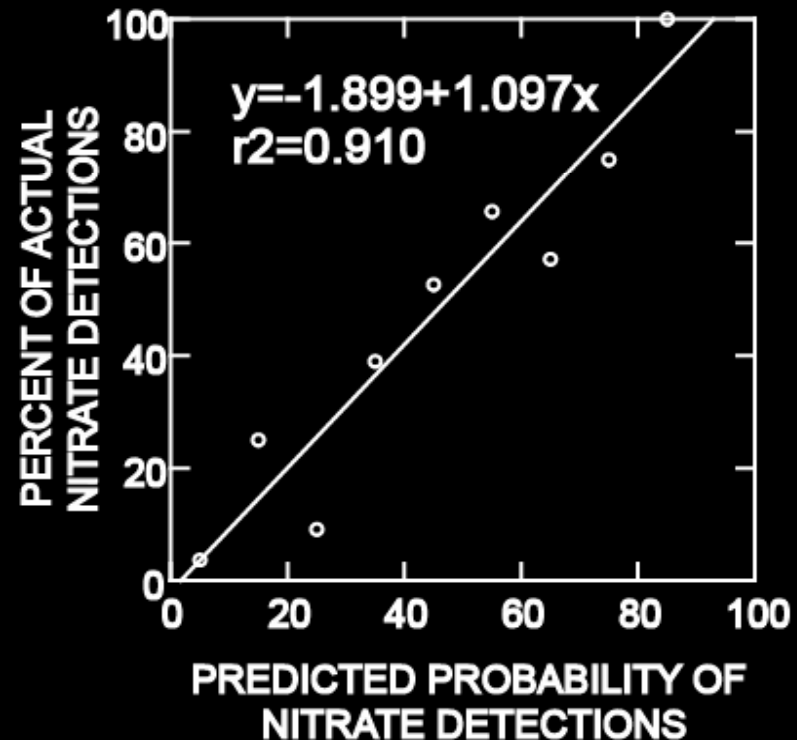


VERIFICATION OF NITRATE MODELS USING USGS DATA, NITRATE CENSORED TO 5 mg/L

Without Fertilizer Use Estimates



With Fertilizer Use Estimates



CONCLUSIONS

- Probability models are a cost effective use of GW monitoring information because they extrapolate correlations made in areas of known GW quality to areas where no sampling has been performed.
- Probability models are more defensible than old vulnerability maps like DRASTIC because they quantify the actual probability of contamination.

A photograph of a sunset scene. In the foreground, the dark silhouettes of palm fronds are visible on the left side. On the right side, the rigging and mast of a ship are visible. The sky is a mix of orange, yellow, and blue, with a bright sun low on the horizon. The overall mood is serene and tropical.

Questions?

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