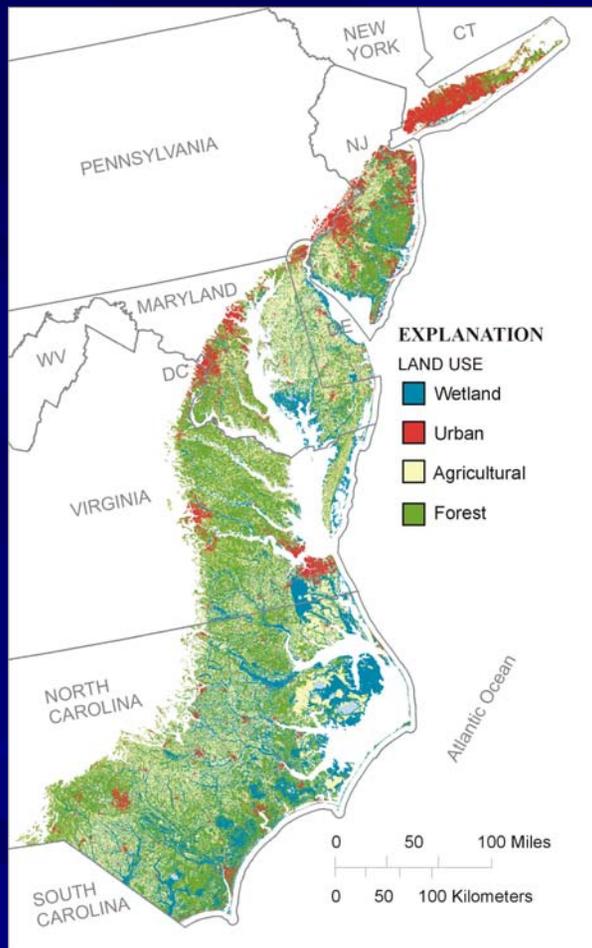


NATURAL AND HUMAN INFLUENCES ON WATER QUALITY IN A SHALLOW REGIONAL UNCONSOLIDATED AQUIFER, NORTHERN ATLANTIC COASTAL PLAIN

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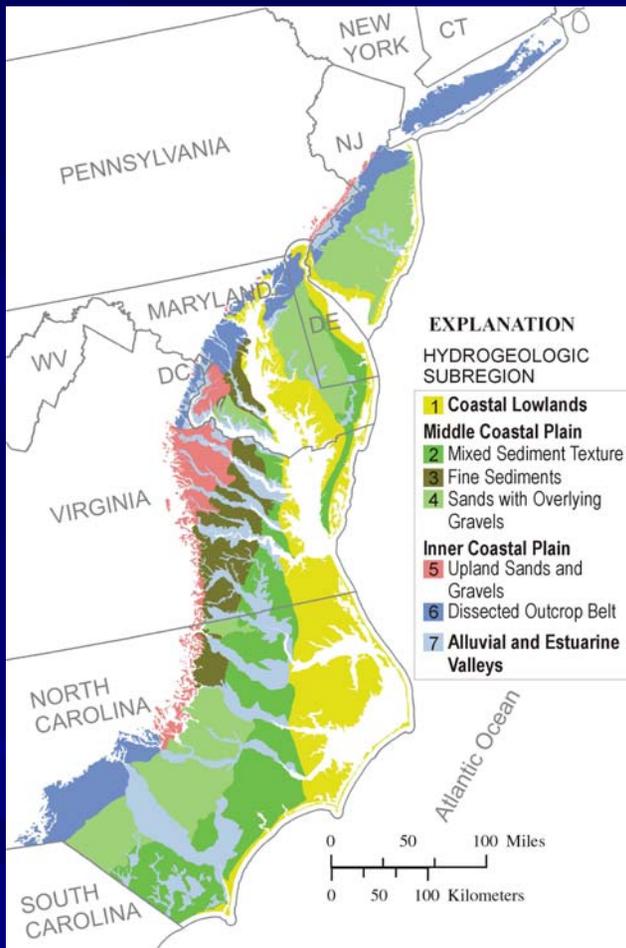
U.S. Geological Survey
National Water-Quality Assessment Program

The Coastal Plain



- Includes the Coastal Plain Physiographic Province from North Carolina through Long Island
- Great diversity of land use and associated potential influences on ground water quality

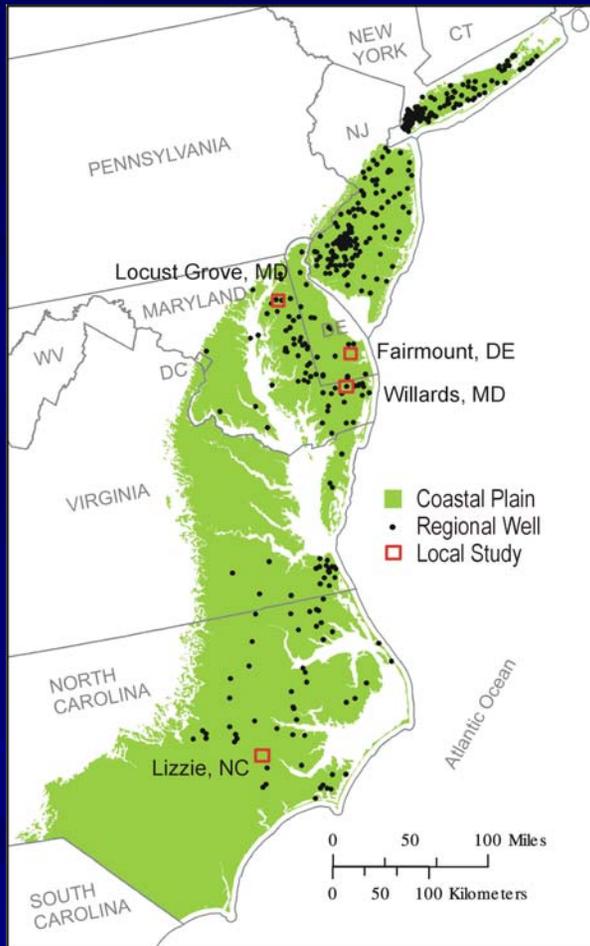
The Coastal Plain



- Surficial and near-surface geology is quite variable
- Sediments are permeable in most areas and the aquifer is vulnerable to chemical applications
- Human influences have been observed in shallow ground water in parts of the aquifer system since at least the 1970s
- Shallow ground water is an important local and regional resource

From USGS PP 1680

Objectives and Approach



- To document and understand interacting natural and human influences on shallow ground-water quality
 - At the regional scale, in 409 wells (1991-2003)
 - Along local flow paths in four different settings (1999-2003)
 - Analysis includes nutrients and pesticides

Approach

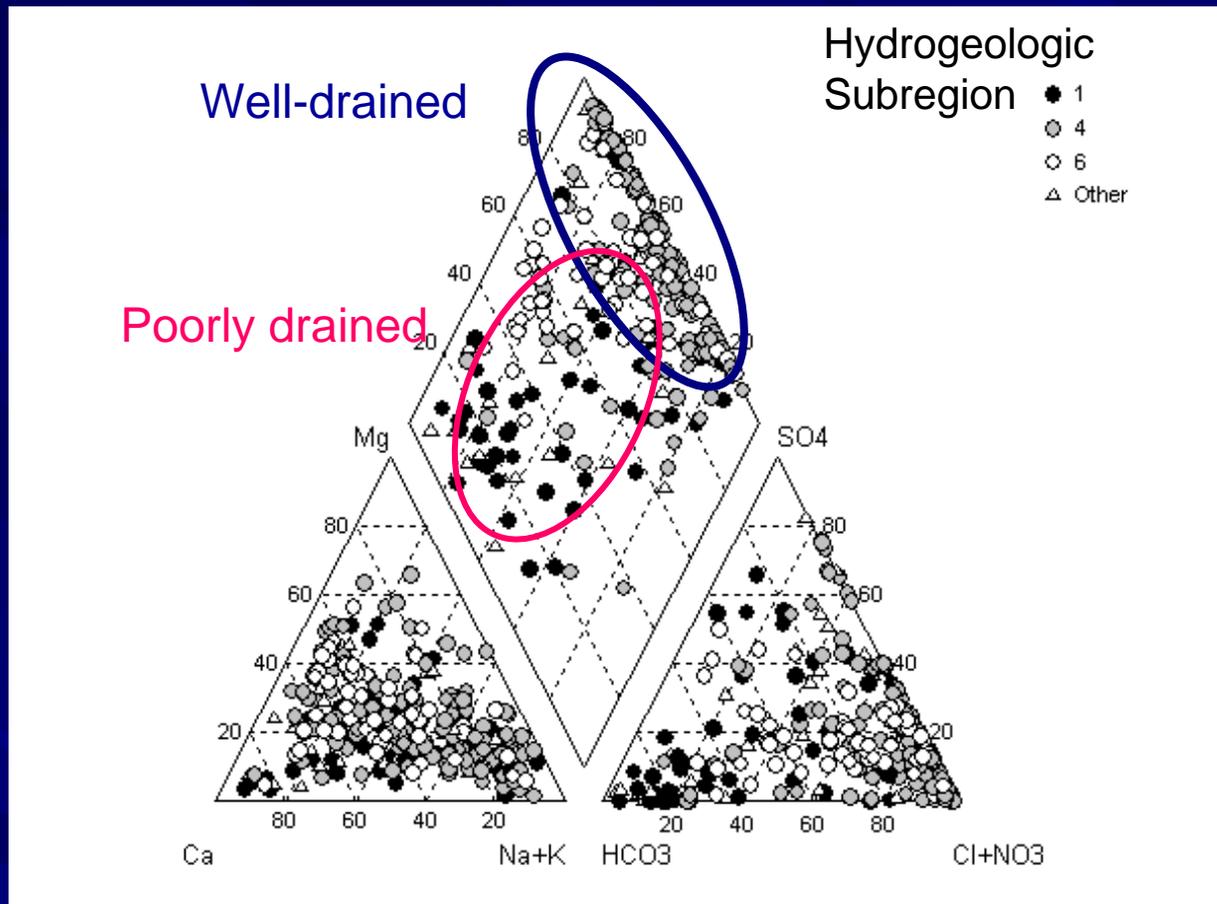
■ At the **Regional** scale:

- Various statistical approaches (such as correlation, PCA, and logistic regression) were used to examine potential influences on water quality
 - Including: land use, soils, hydrogeologic setting, depth, geochemical conditions (such as redox)

■ At the **Local** scale:

- Water quality examined using empirical and statistical approaches along local flowpaths in agricultural area
 - Including: agricultural practices, soils, age-dates, isotopic analyses, ground-water flow patterns

Major Chemistry



Regionally (n=272), ground-water in many areas is generally oxic, and reflects human influences:

- Median DO: 3.8 mg/L
- Median SC: 247 μ S/cm

Differences in major chemistry are apparent among hydrogeologic settings

Major Chemistry

- At the regional scale, the majority (72%) of variability in major chemistry is related to three principal components

PC	Var.	+ Loadings	- Loadings	Interpretation
1	.41	SC, Ca, Mg, Na, Cl, HCO ₃ , pH, SiO ₂		Ionic strength
2	.22	NO ₃ , DO	Fe	Redox
3	.09	pH, HCO ₃ , Ca	Mn, Na, Cl, SO ₄	Different sources??

Nitrate

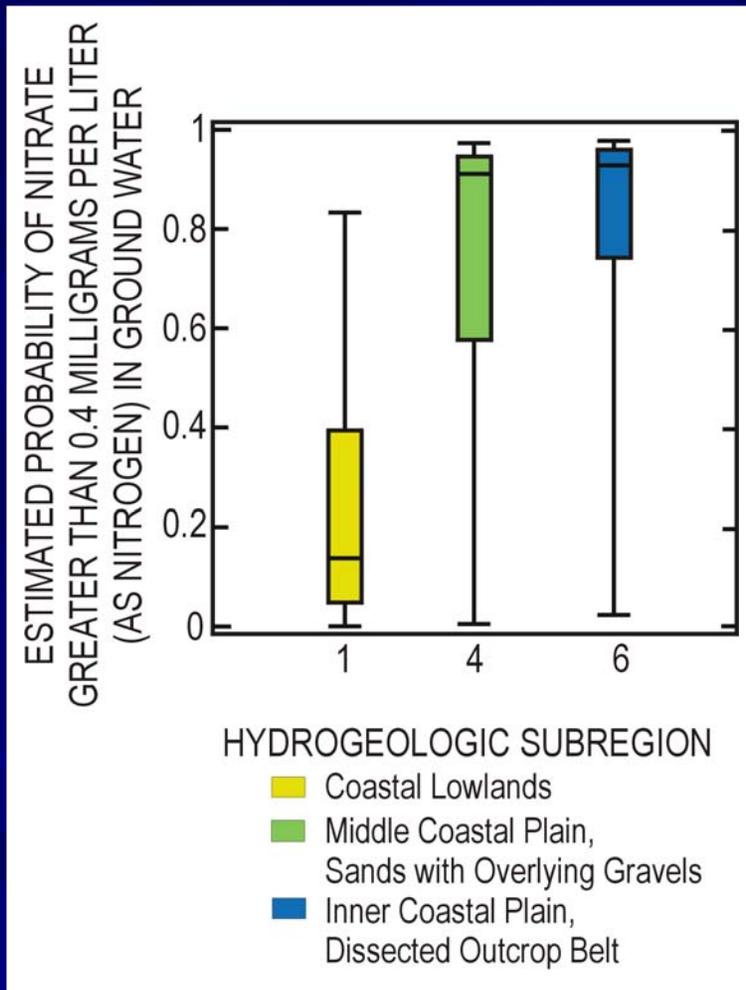
- Concentrations (n=352) are quite variable regionally, but reflect human influences on ground water in many areas
 - Median = 2 mg/L (as N)
 - Maximum = 56 mg/L
- Concentrations exceeded 10 mg/L in samples from 52 of 352 regional wells
- Median nitrate concentrations in the different local flow-path study areas ranged from from 5 to 15 mg/L – Median greater than 10 mg/L in the well-drained, oxic sites, similar to regional

Nitrate - Logistic Regression

Regionally, the occurrence of nitrate at different concentrations is related to similar hydrogeologic conditions, but possibly different sources in different areas

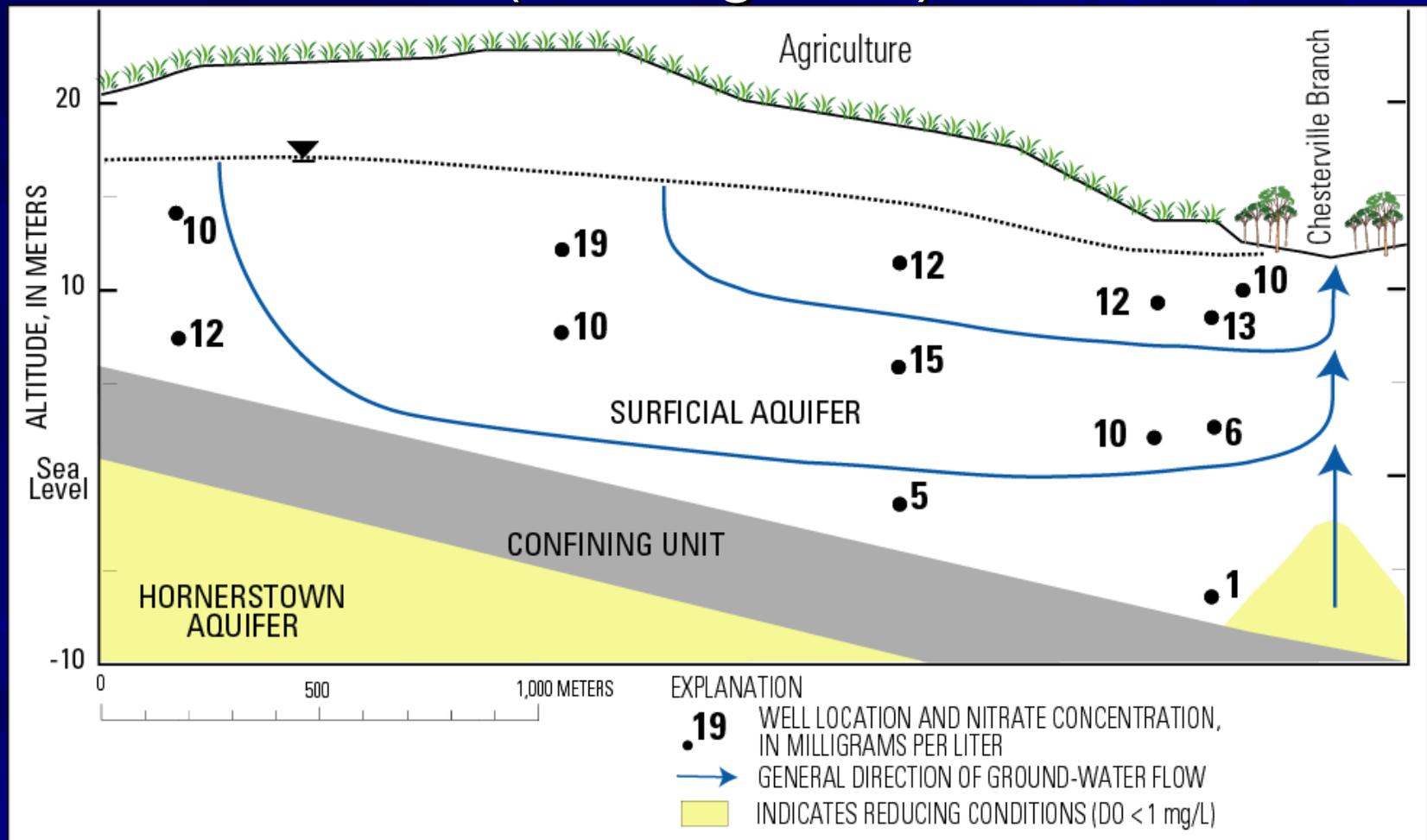
Model	Variables	c
P ($\text{NO}_3 > 0.4$ mg/L natural levels)	Forest (-), SC (-), DO, Hydrogeologic Subregion	0.91
P ($\text{NO}_3 > 3$ mg/L)	Forest (-), well drained soils (+), Agriculture (+), DO	0.84

Nitrate

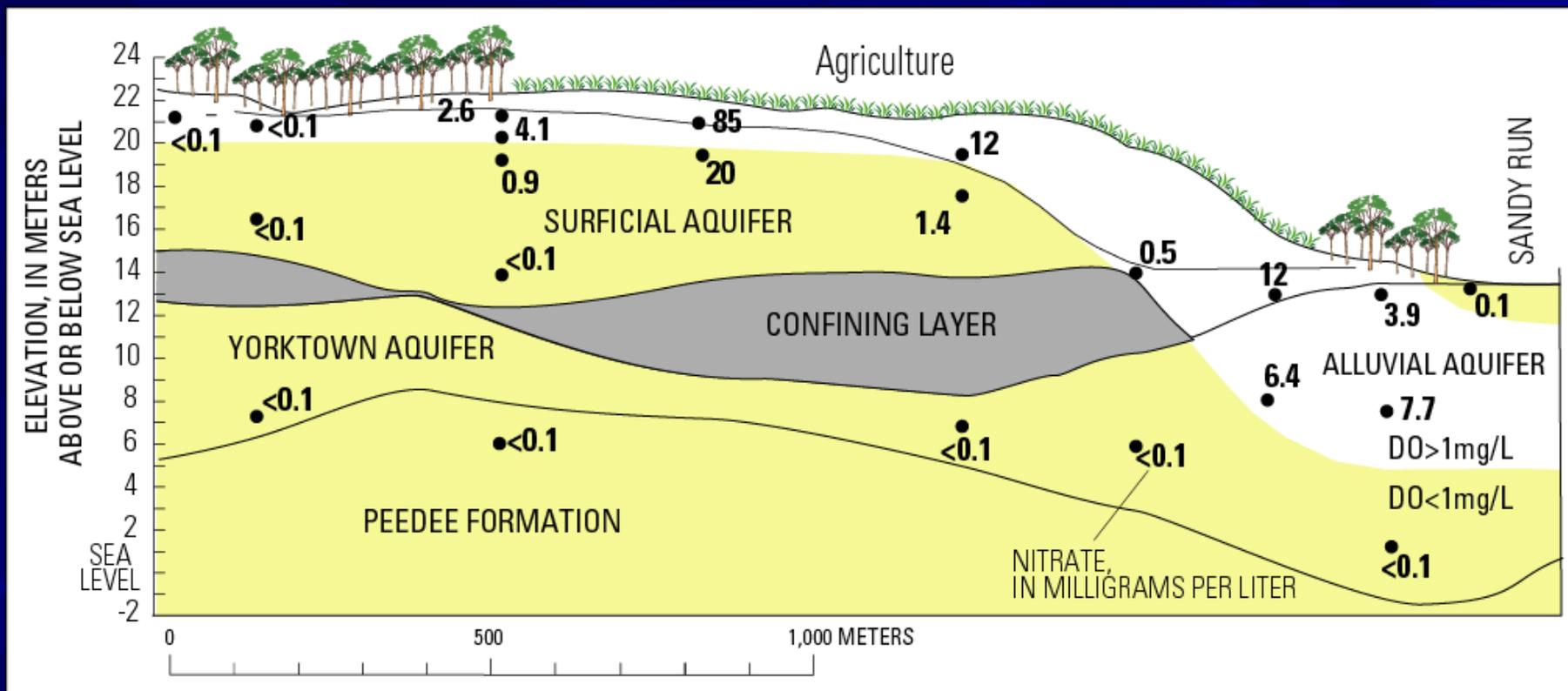


- Regionally, nitrate concentrations are less likely to exceed estimated natural levels (0.4 mg/L) in the Coastal Lowlands than in other hydrogeologic settings

Well-Drained: Locust Grove, MD (Subregion 4)



Poorly Drained: Lizzie, NC (Subregion 1)



Modified from USGS SIR 2004-5283

Pesticides

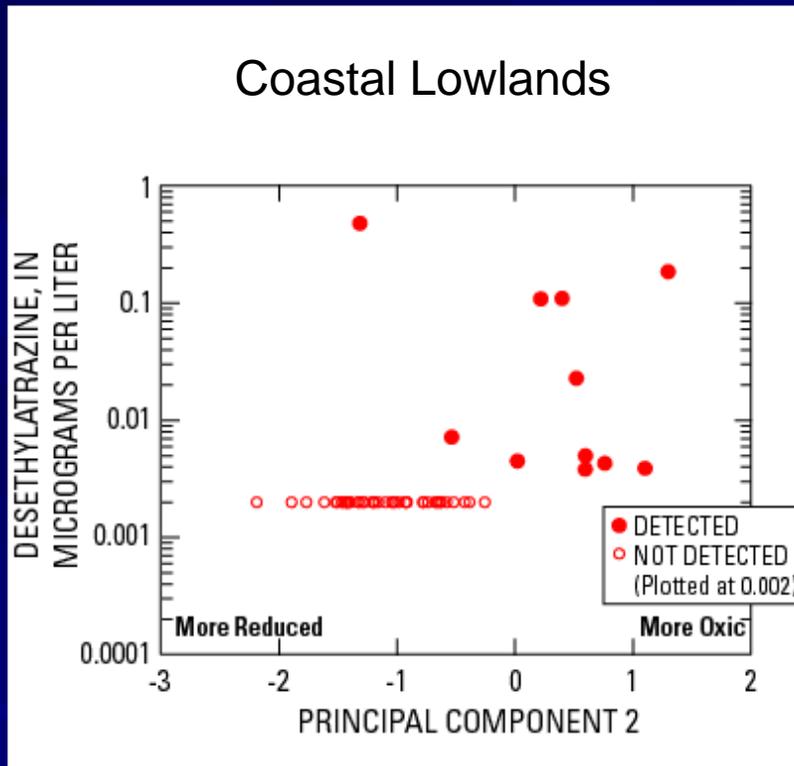
- Pesticide compounds are present in ground water in many parts of the Coastal Plain
 - herbicides most often detected
- Atrazine, DEA, Metolachlor, and Simazine were the most commonly detected regionally
 - Nearly half (46 percent of 338) of samples contained at least one of these four compounds
 - Concentrations rarely exceeded 0.1 ug/L
- Atrazine, DEA, and Metolachlor also most common in agricultural flow path study areas
 - All samples had a least one pesticide compound

Pesticides – Logistic Regression

The occurrence of selected herbicides in regional ground water is related to agricultural land use and ground-water geochemistry

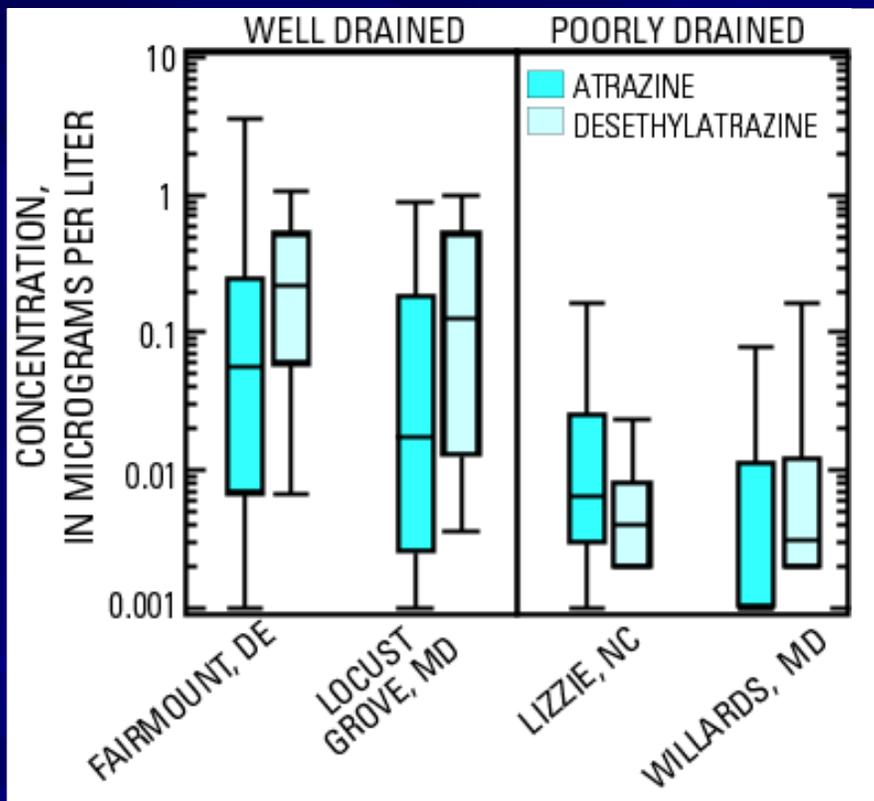
Model	Explanatory Variables	c
P(Atrazine or DEA detected)	PC2 (+) <i>oxic</i> , Agriculture (+) PC1 (-) <i>ionic strength (dilute)</i> , PC3 (+) <i>liming</i>	0.86
P(Metolachlor detected)	PC2 (+) <i>oxic</i> , Agriculture (+), PC1 (-) <i>ionic strength</i>	0.86

Pesticides



- Regionally, concentrations of DEA are generally higher in ground water in more oxic areas
- Relatively permeable, organic-poor sediments that promote oxic ground water also generally favor pesticide movement to ground water

Pesticides-Local Scale



- Local hydrogeologic condition affect concentrations of Atrazine and DEA in ground water
- Conditions that promote oxic ground water also generally favor pesticide movement to ground water
- Higher concentrations and detecs in well drained, less in poorly drained areas

Summary – benefits of methods

- The surficial aquifer in the Coastal Plain is affected by interacting natural and human influences.
 - Nitrate commonly exceeds natural levels, and pesticides are detectable in many areas
- Results from local studies help us develop regional hypotheses and interpret regional data; regional interpretations help us understand the distribution of conditions represented by local studies
- Summaries of major-ion chemistry (such as PCA) may be particularly useful for understanding the regional distribution of certain chemicals as they reflect a summary of natural and human influences on ground water.
- A combination of geographic information with available geochemical data may provide considerable insight into the occurrence of certain chemicals over use of geographic information alone.

Thank you and Questions

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Check back table for handouts