Can Contamination Potential of Ground Water to Pesticides be Identified from Hydrogeological Parameters?

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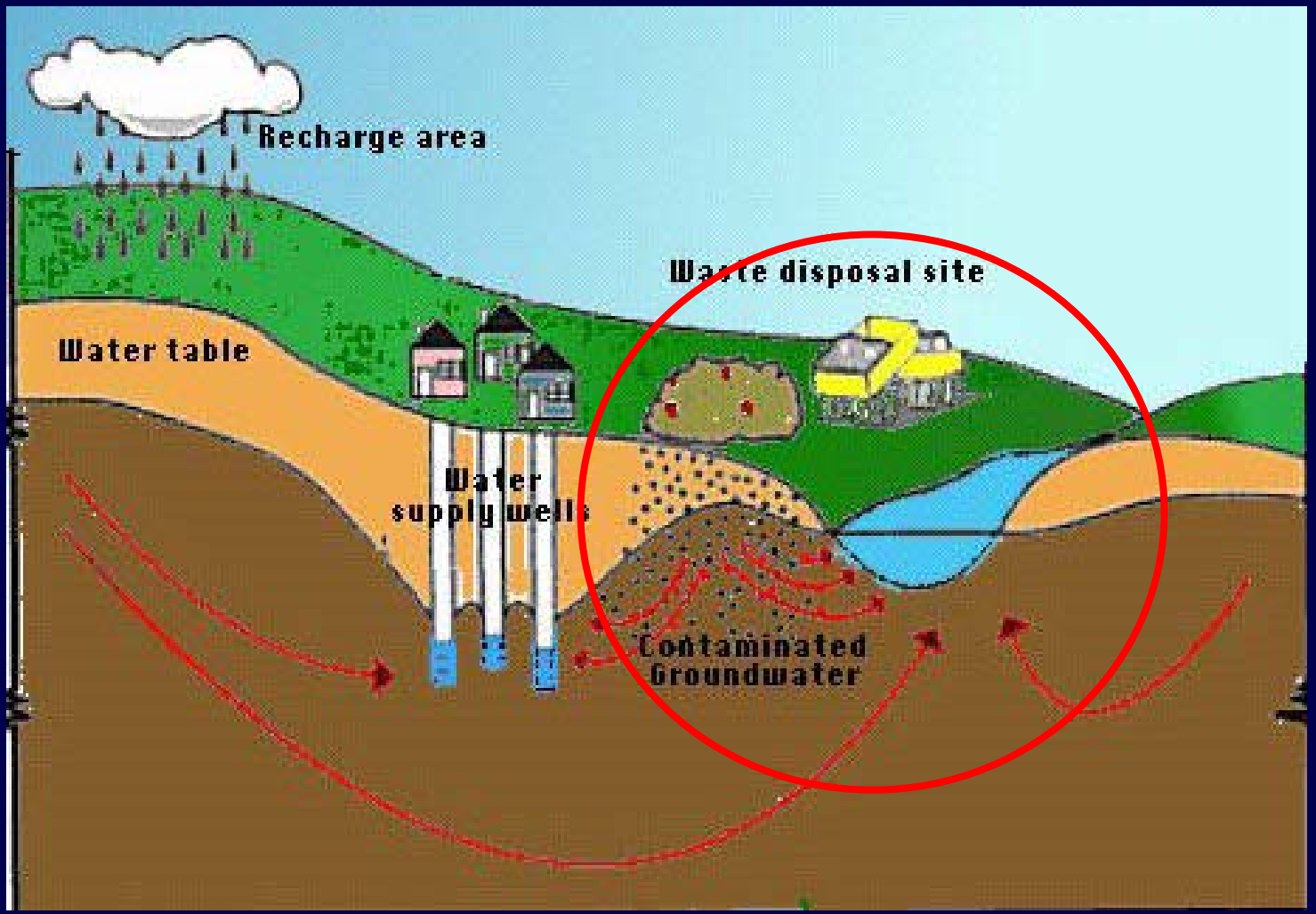
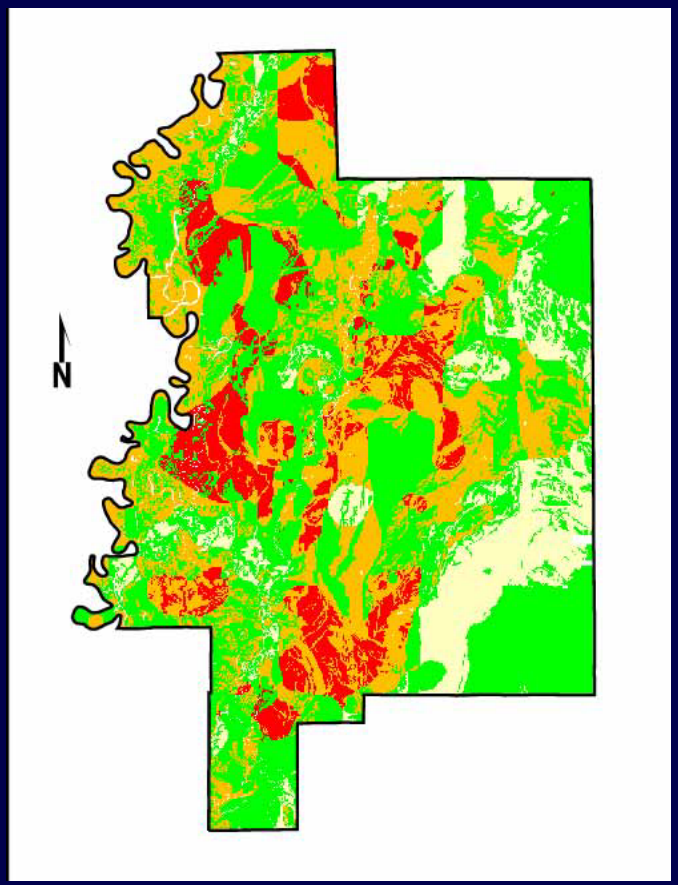
NPS!! The Problem!!



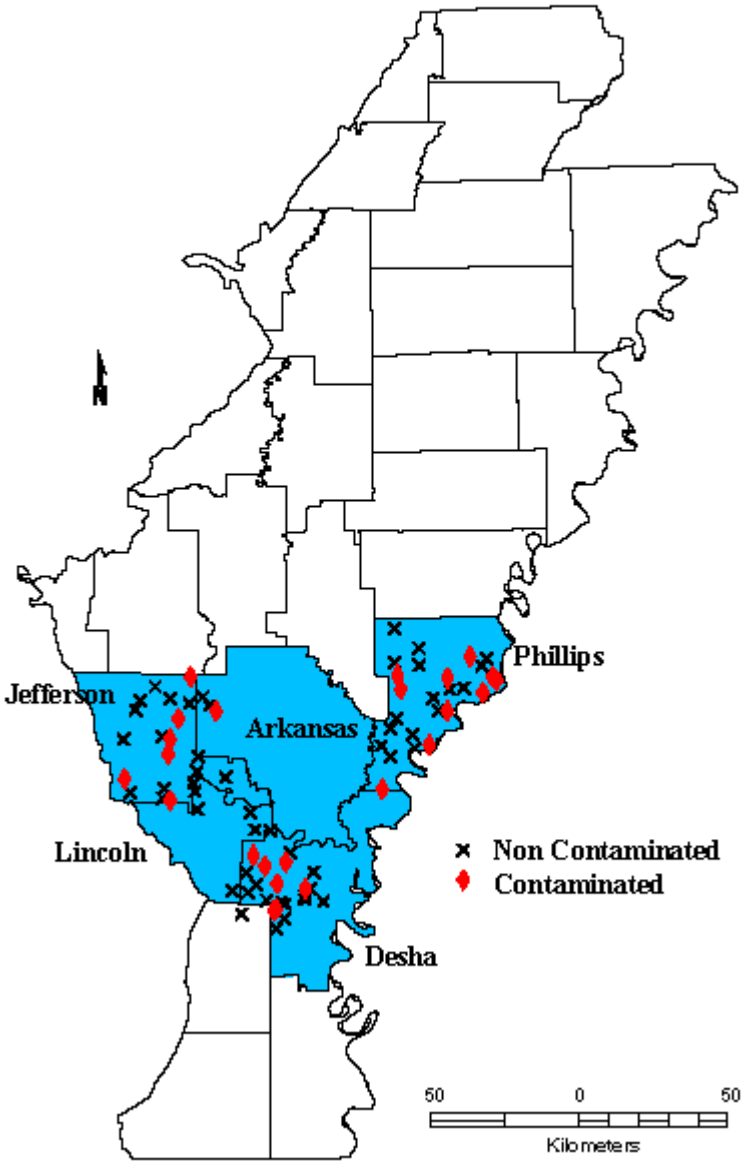
Solution: Contamination Potential Mapping DRASTIC

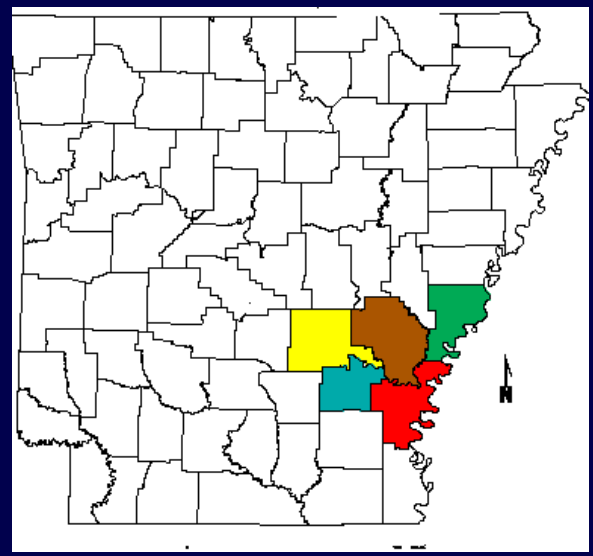


Low
Moderate
Moderately High
High

0 miles 12

Arkansas Delta
Location of Wells
Sampled by DEQ





Introduction

- Arkansas has a state management plan (SMP) for pesticide monitoring of ground water
- The Department of Environmental Quality (DEQ) routinely samples 76 irrigation wells in 5 counties
- 61 pesticides and degradation products were analyzed by DEQ
- Pesticide use is primarily for weed control in soybeans, cotton and rice

Objective

- To determine the key hydrogeologic parameters that might play a critical role in contamination of ground water by pesticides using GIS and geostatistical approach).

Key words: GIS & Geostatistics

Spatial Data Layers

- Well Location/Contamination
- Soils
- Geology
- Landuse
- Thickness of the Confining Unit (claycap)
- Recharge of Ground Water
- Depth to GW

Sources of Spatial Data

• Well Location/Contamination	DEQ
• Soils	NRCS
• Geology	LGS
• Landuse	CAST
• Claycap	USGS
• Recharge	USGS
• Depth to GW	USGS

Number of Contaminated Wells for Each Pesticide

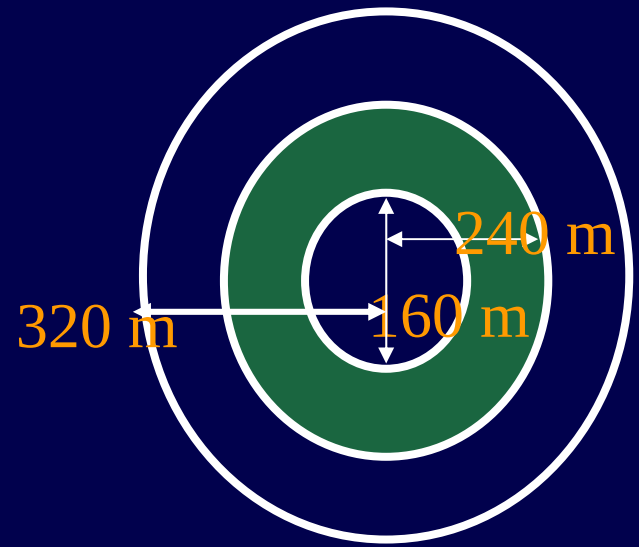
Pesticide	Number
Bentazon	**14**
Metalachlor	**3**
Atrazine	**2**
Ametryn	**2**
Prometryn	**2**
Silvex	**2**
Cyanazine	**1**
Atraton	**1**
Aciflurofen	**1**
Metribuzin	**1**

Software

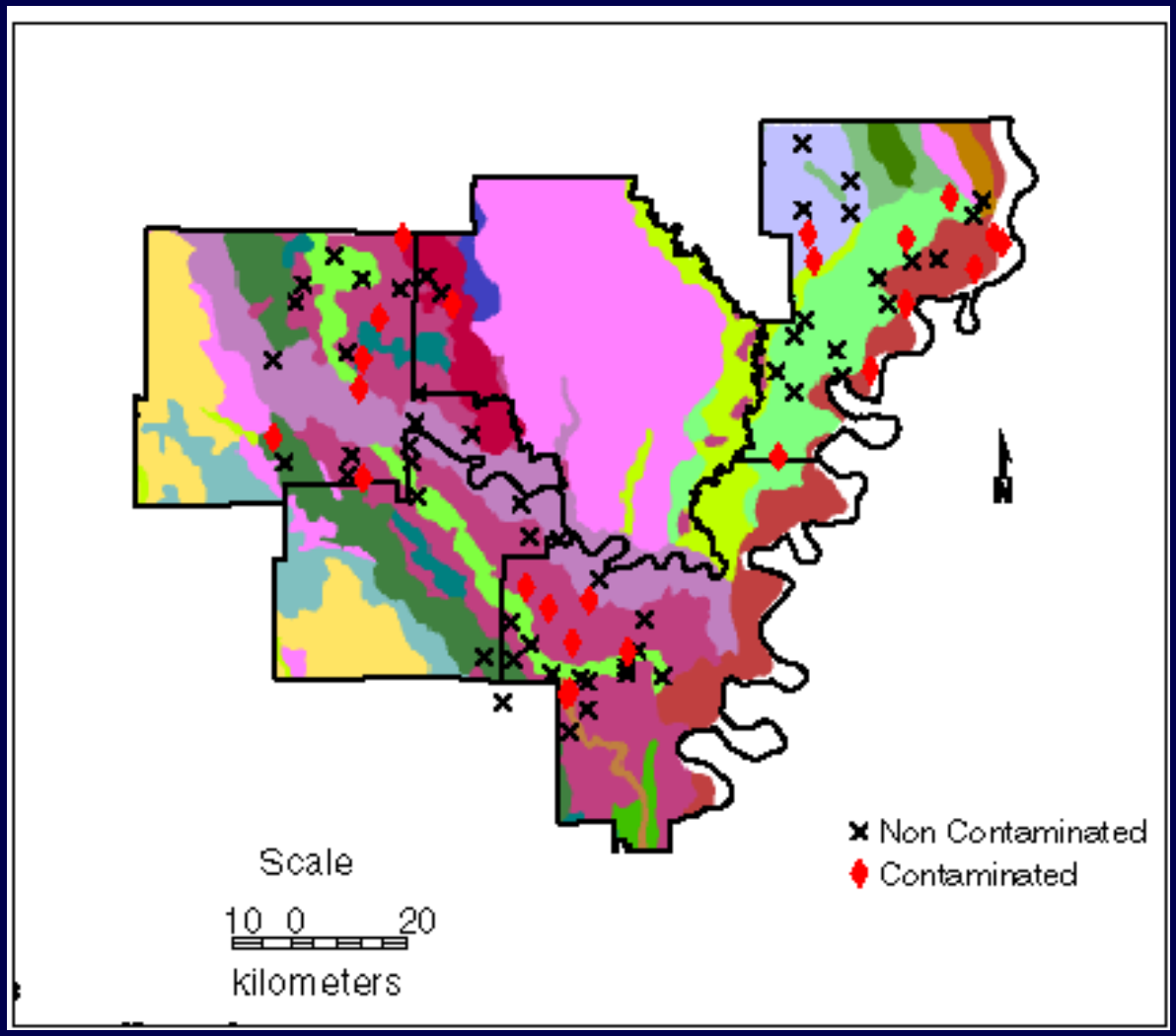
- GRASS, version 4.2
- JMP, version 3.2
- GS+, version 3.1
- MultiSpec

Analyses

- GIS
  - Buffer Analysis
  - Coincidence
- Statistical
  - Descriptive
  - Geostatistics

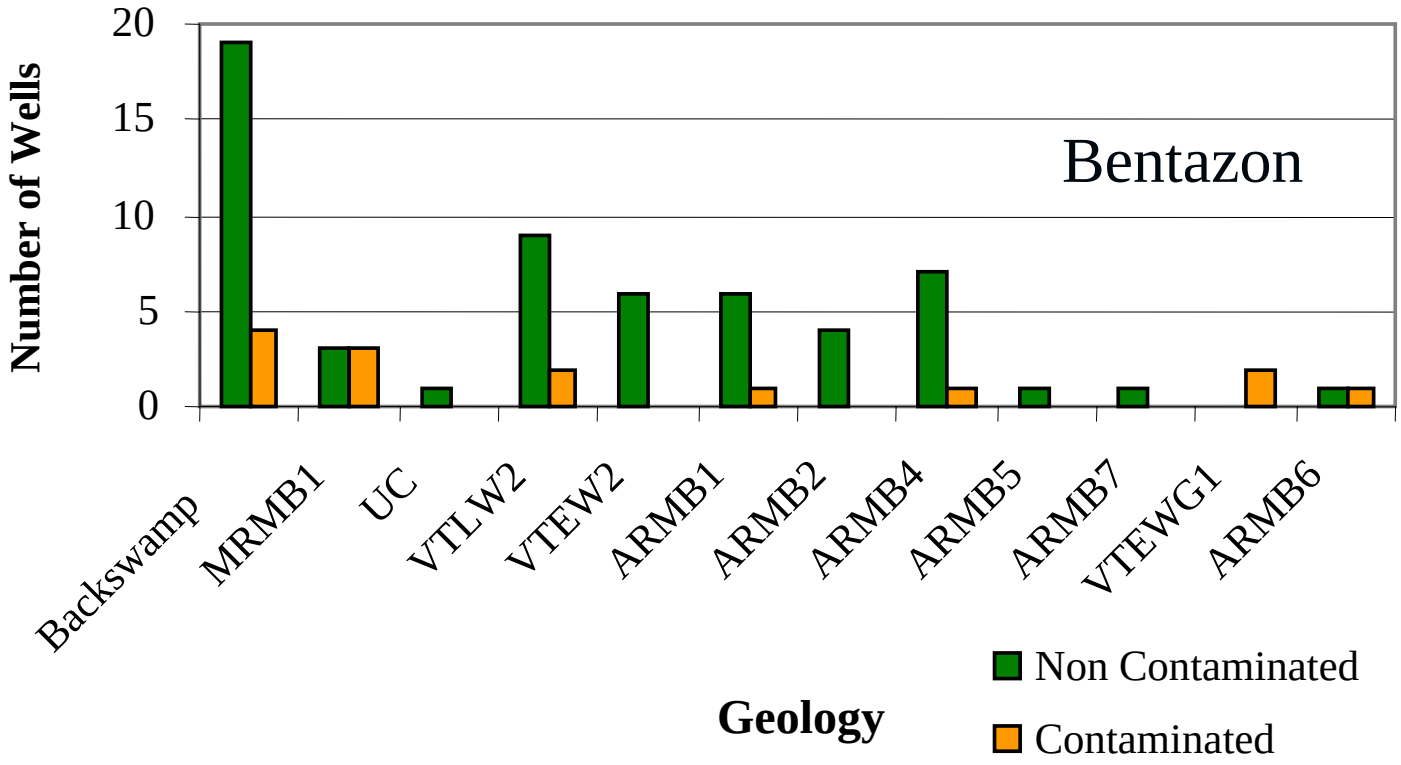


Geology

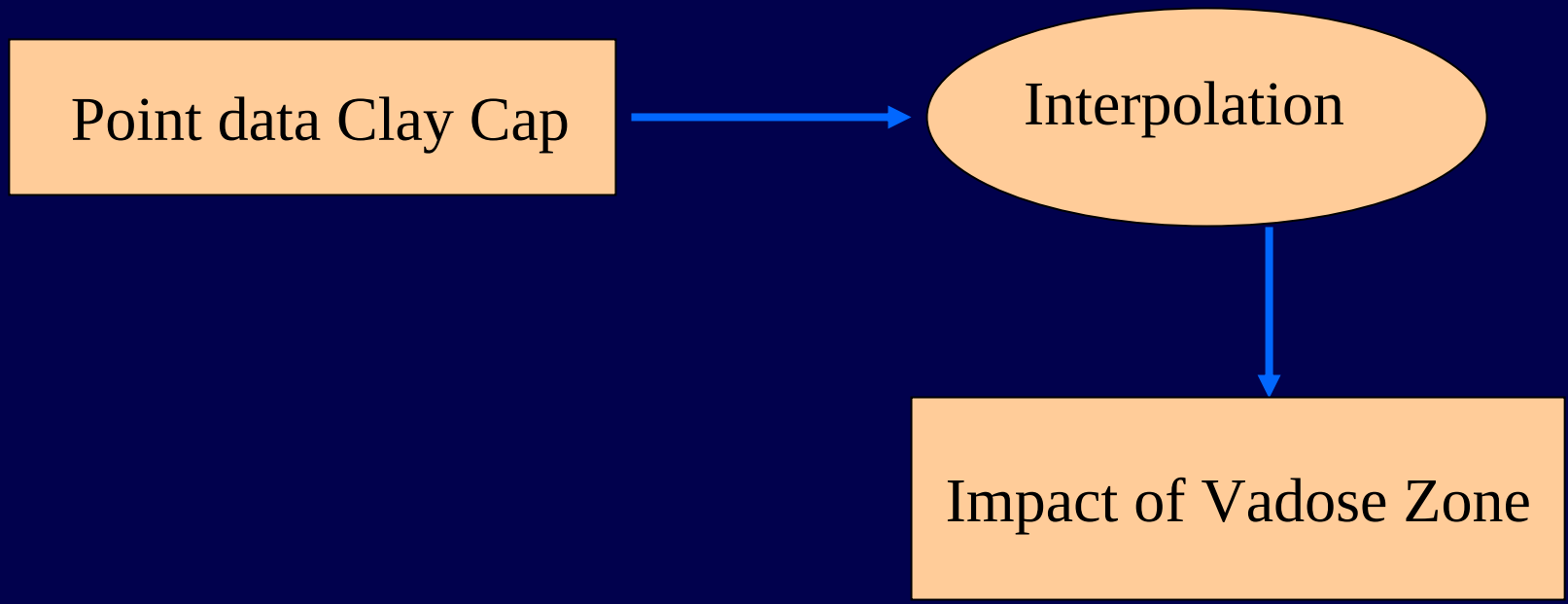


- Prairie Complex
- MRMB1
- ARMB1
- Alluvium
- Backswamp
- VTEW2
- VTLW2

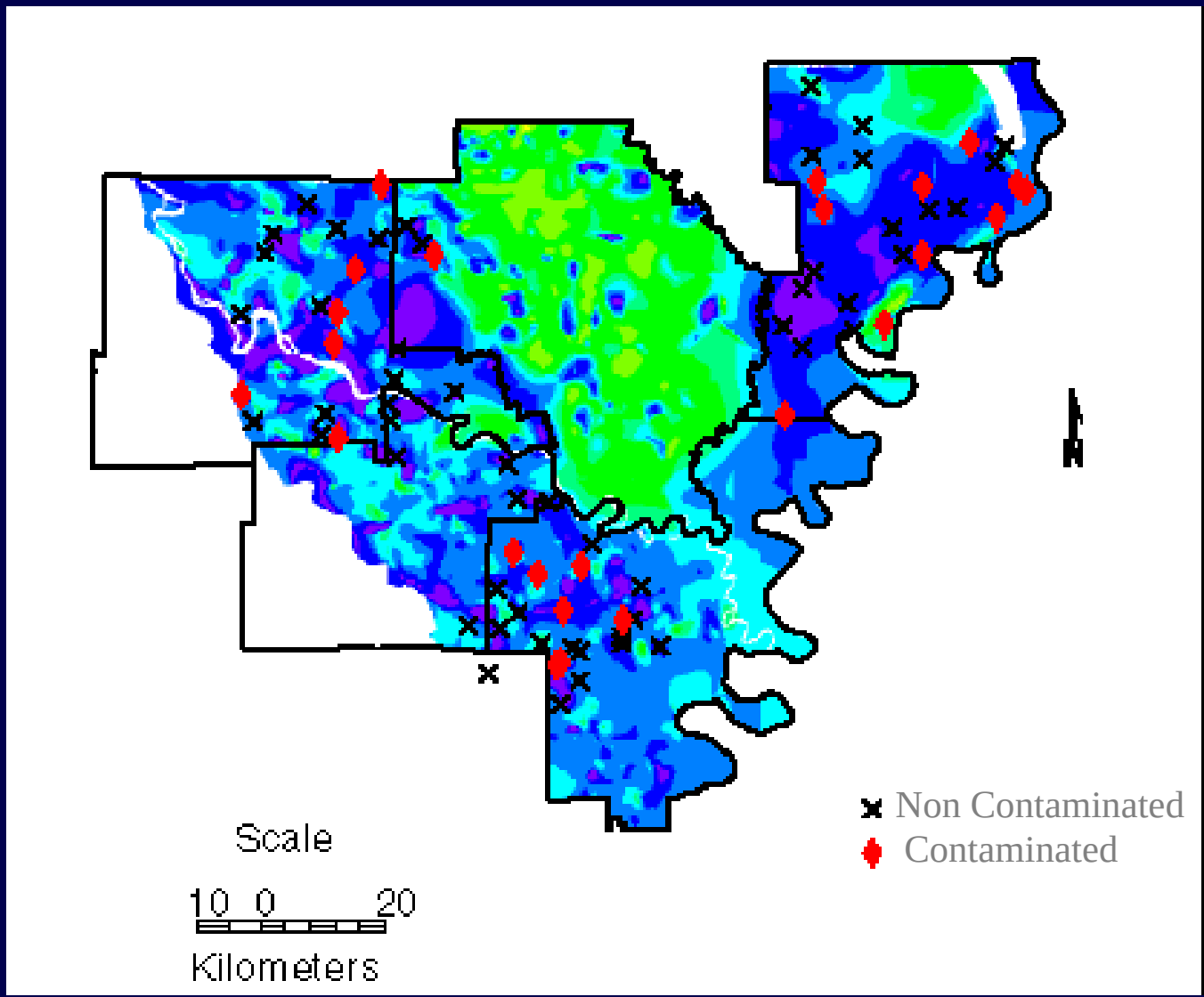
Presence of Bentazon vs. Geology



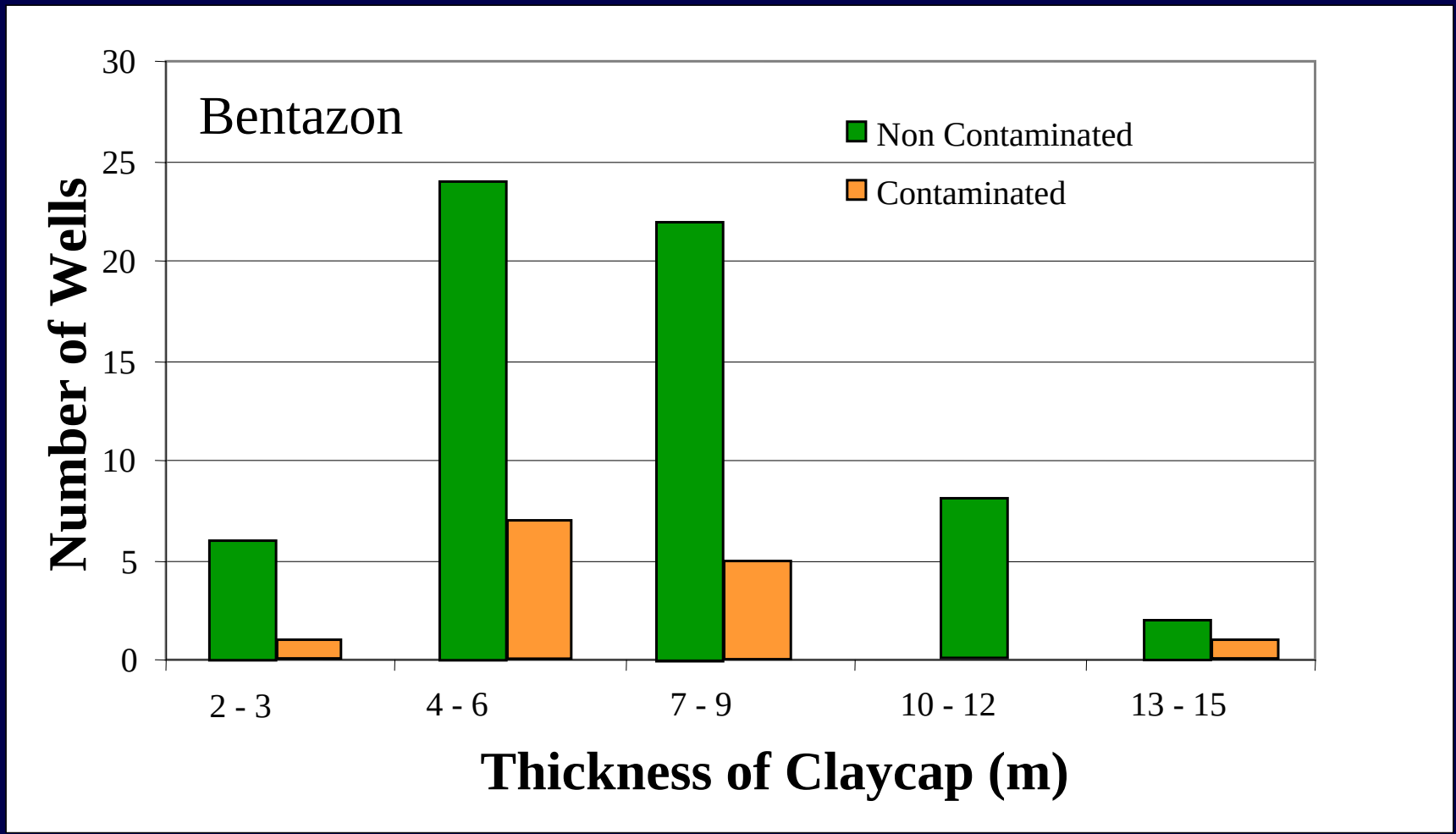
Thickness of the Clay Cap



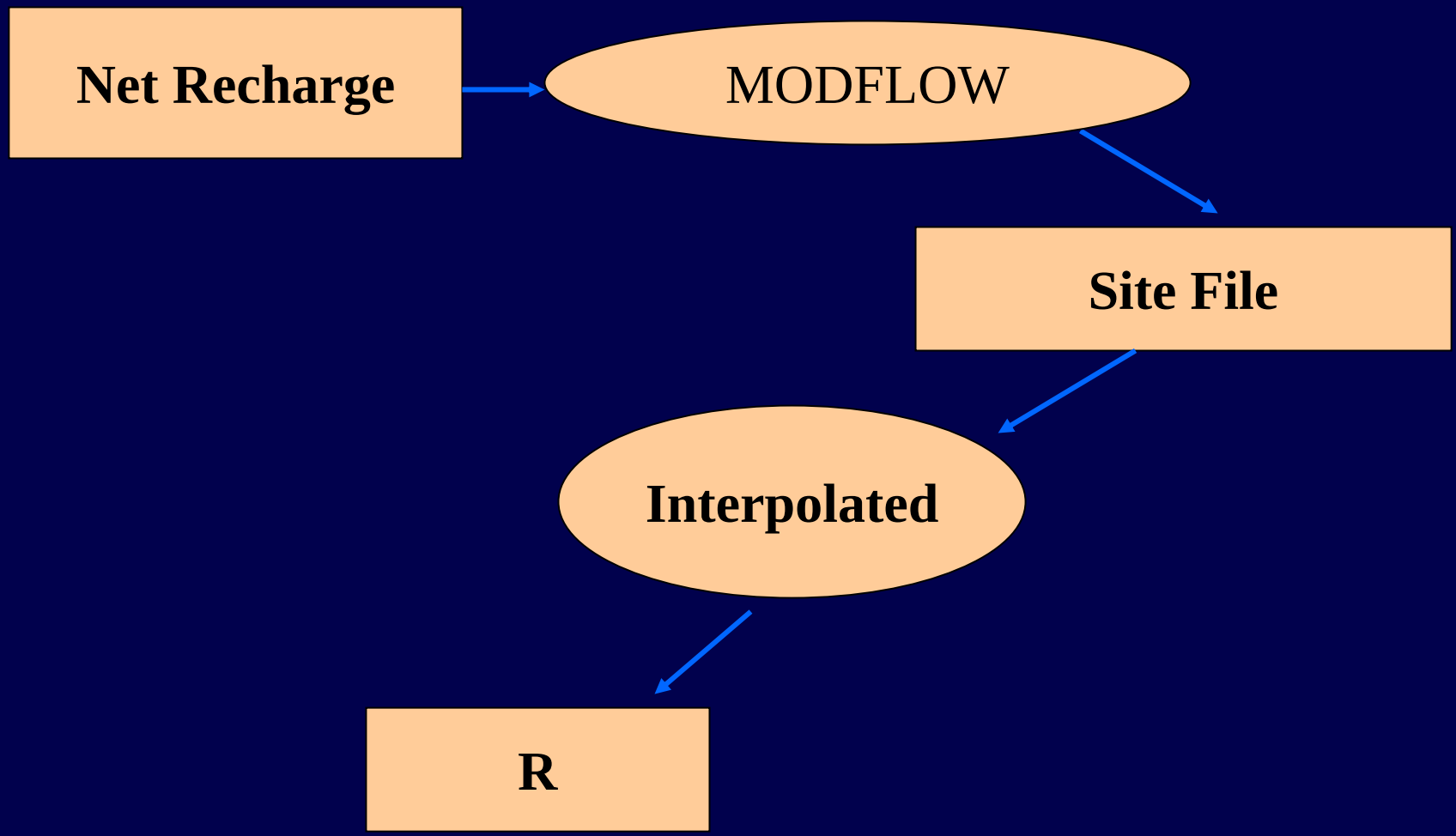
Thickness of Claycap



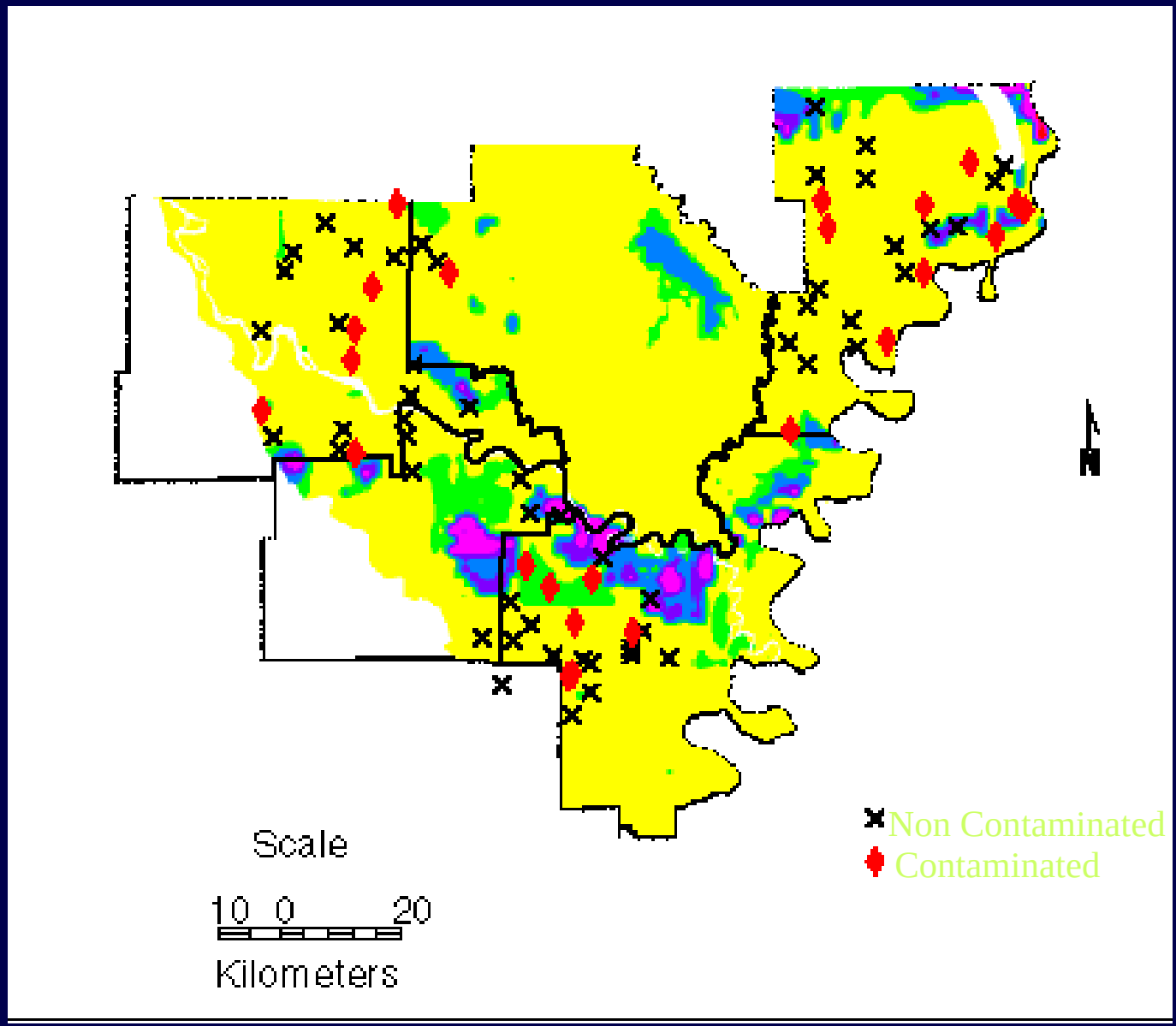
Presence of Bentazon vs. Thickness of Claycap



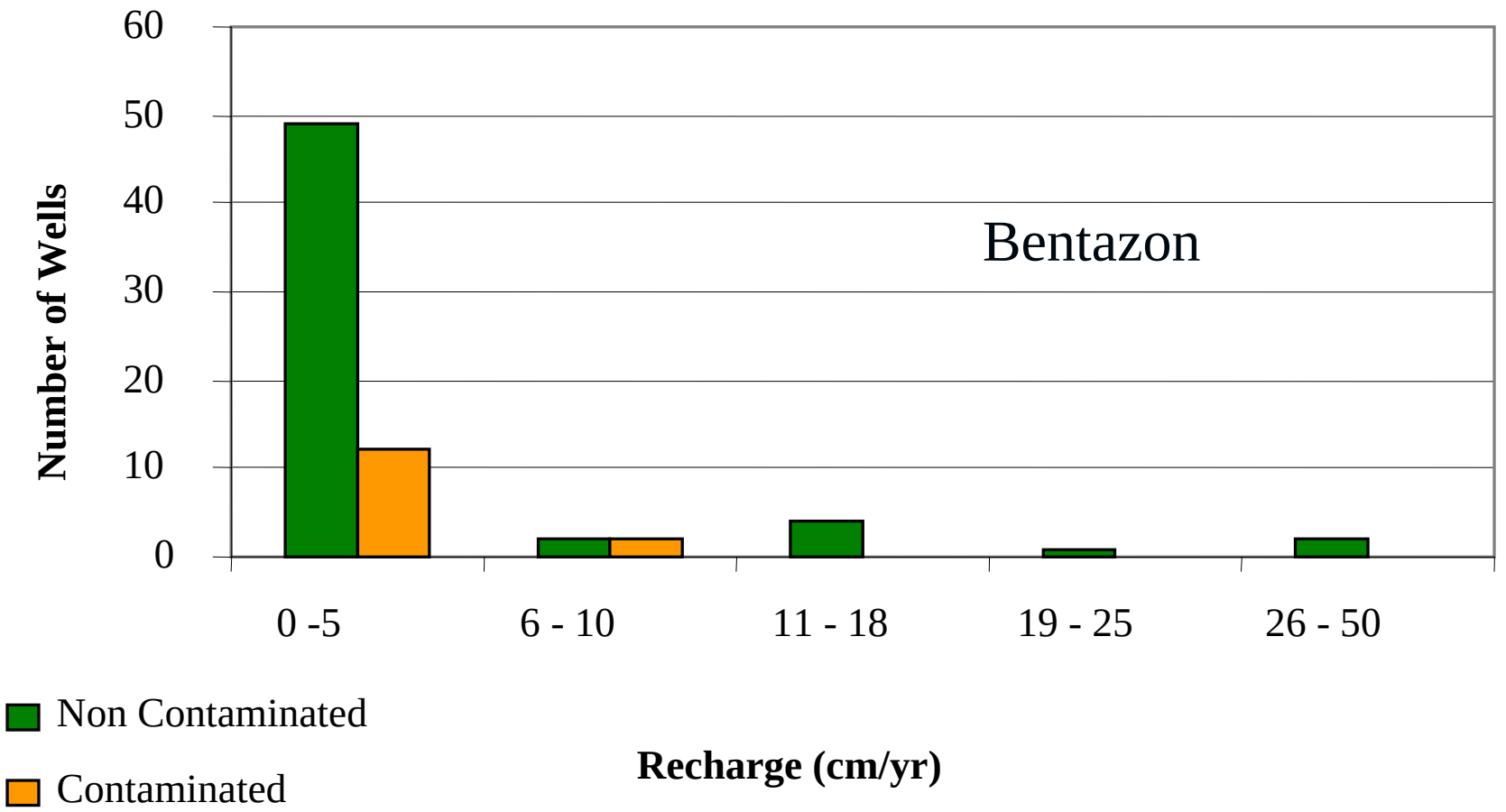
Recharge of Ground Water



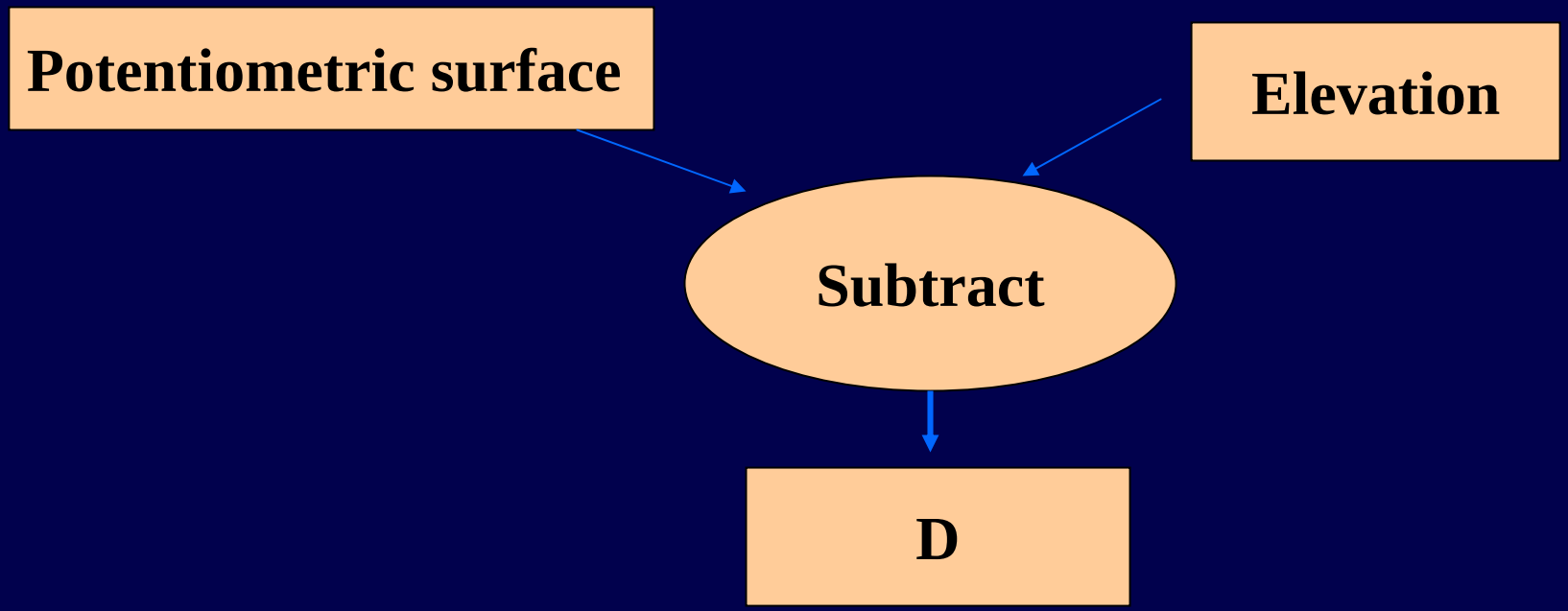
Recharge of Ground Water



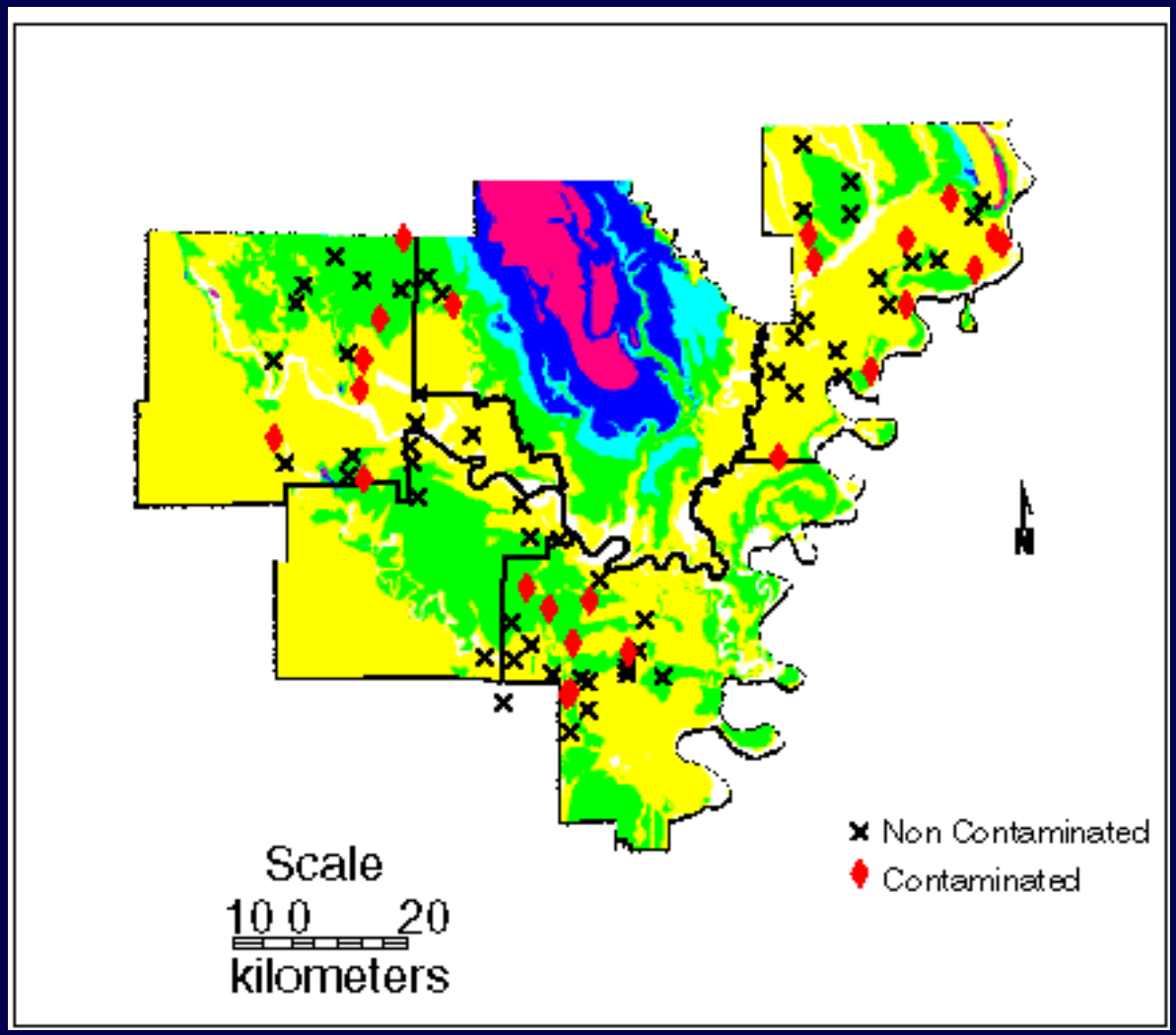
Presence of Bentazon vs Recharge



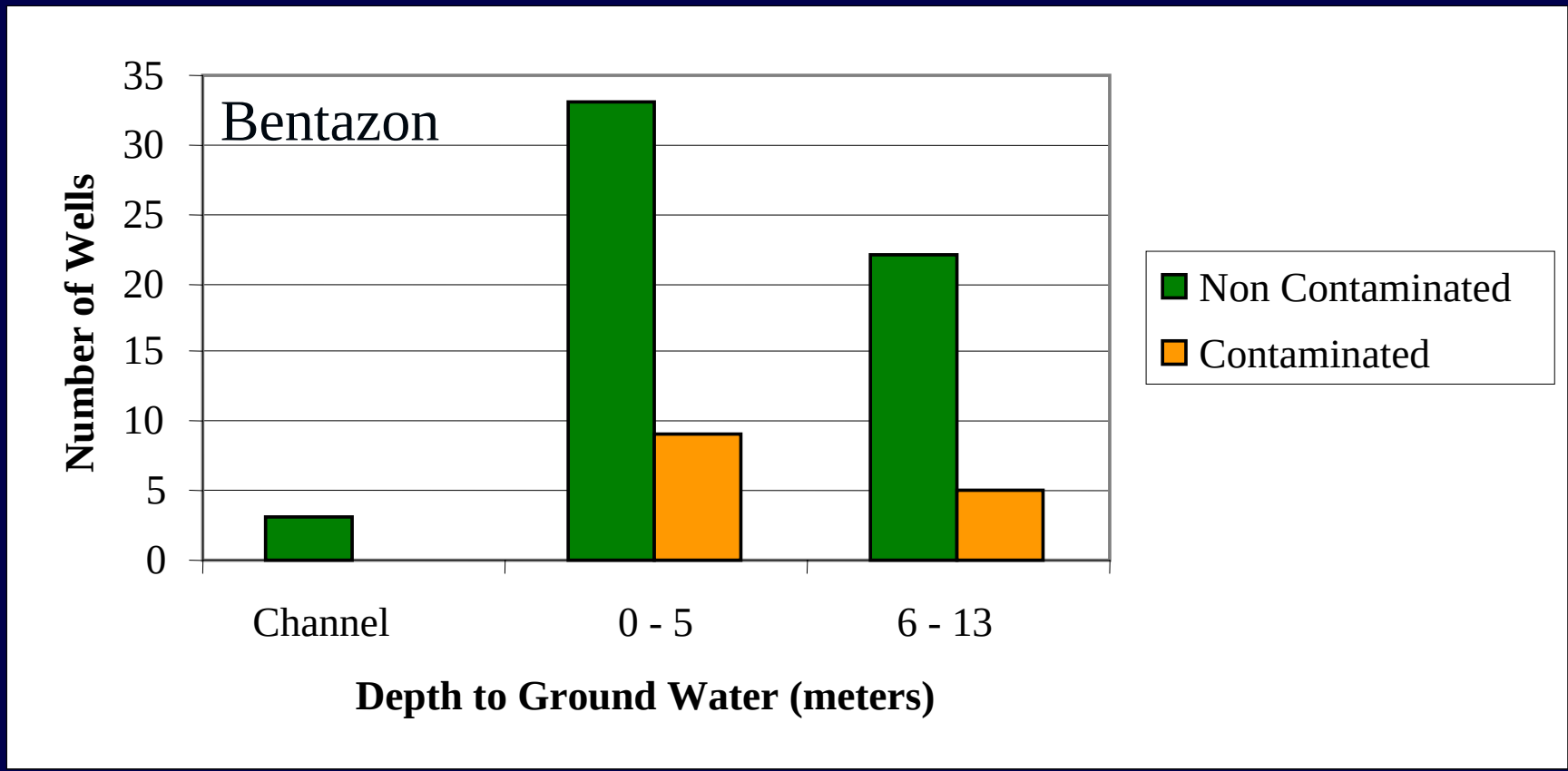
Development of Depth to Ground Water



Depth to Ground Water



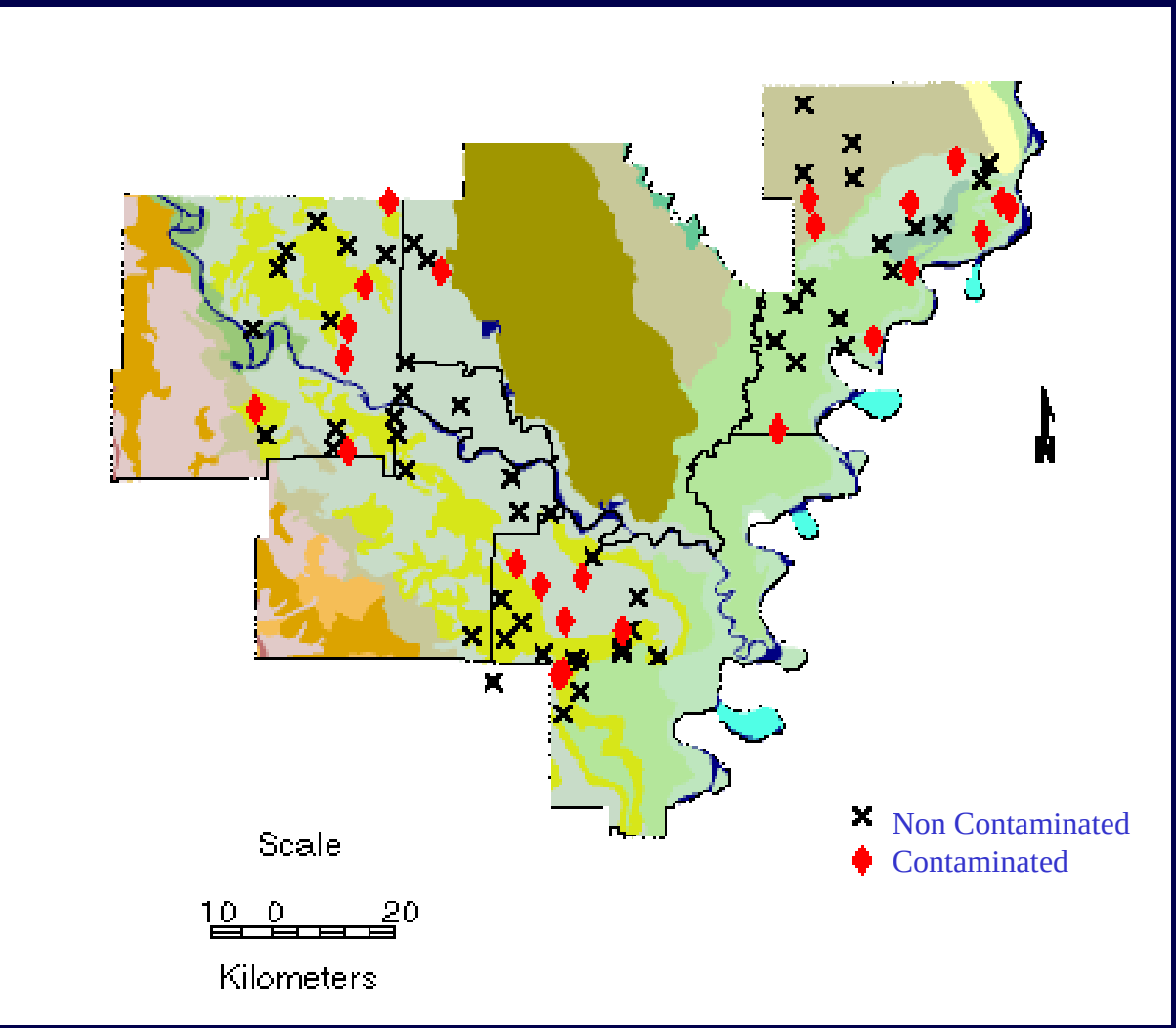
Presence of Bentazon vs. Depth to GW



Soils

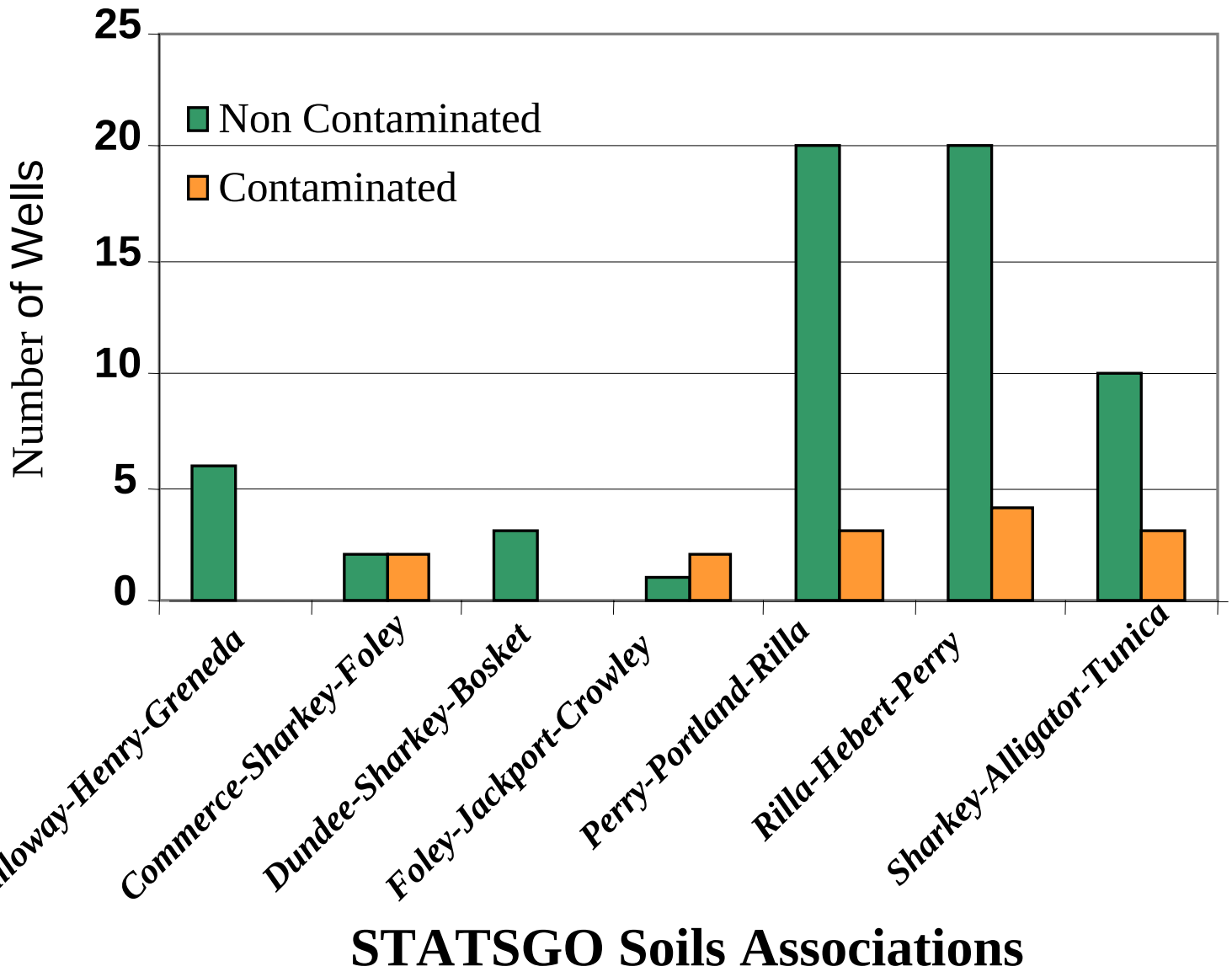
- STATSGO (1:250,000)
  - mapping units: soil associations
- SSURGO (1:24,000)
  - mapping units: soil series
  - surface texture
  - drainage class
  - permeability class

STATSGO Soils

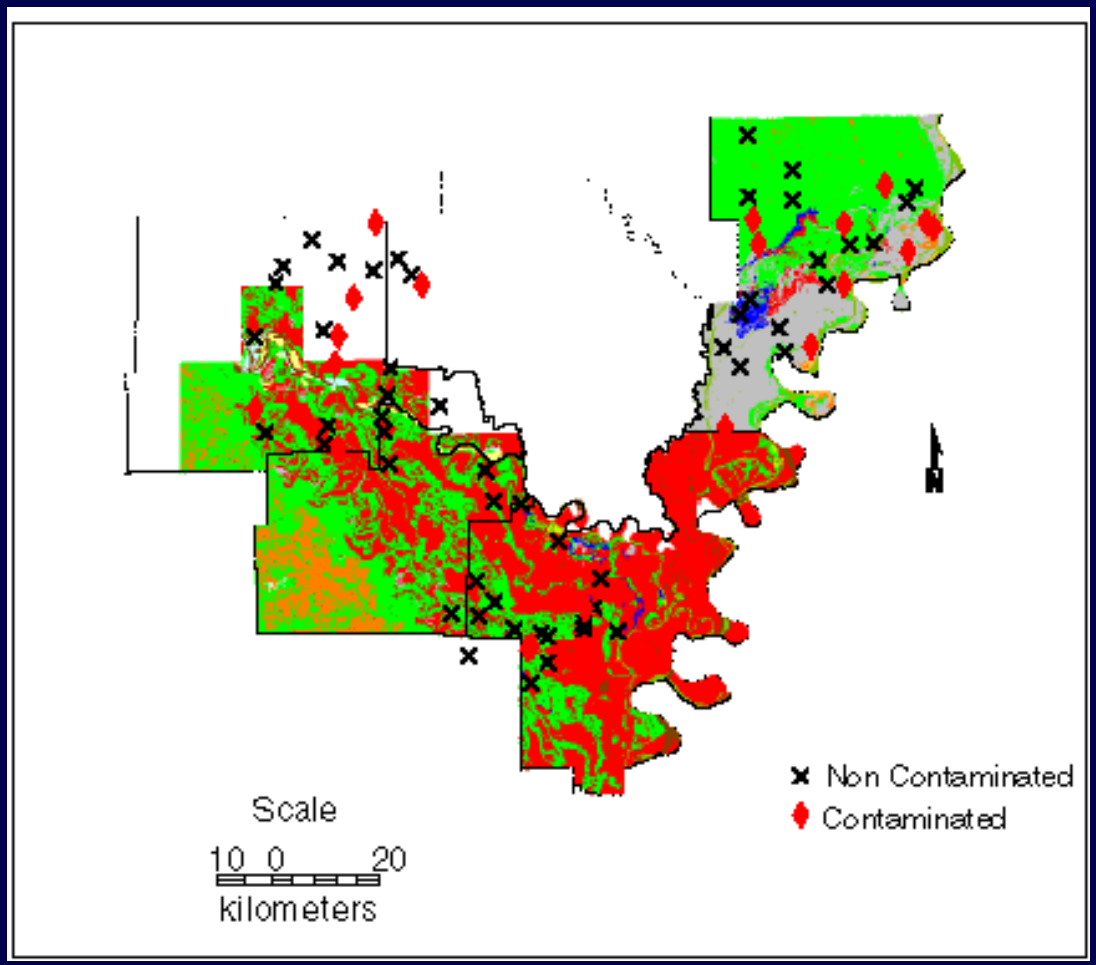


- Perry-Portland-Rilla
- Crowley-Stuttgart-Hilleman
- Calloway-Henry-Grenada
- Sharkey-Alligator-Tunica
- Loring-Memphis-Collins
- Rilla-Herbert-Perry
- Sacul-Savannah-Sawyer
- Smithdale-Savannah-Sacul
- Foley-Jackport-Crowley

Presence of Bentazon vs. STATSGO Soil Associations

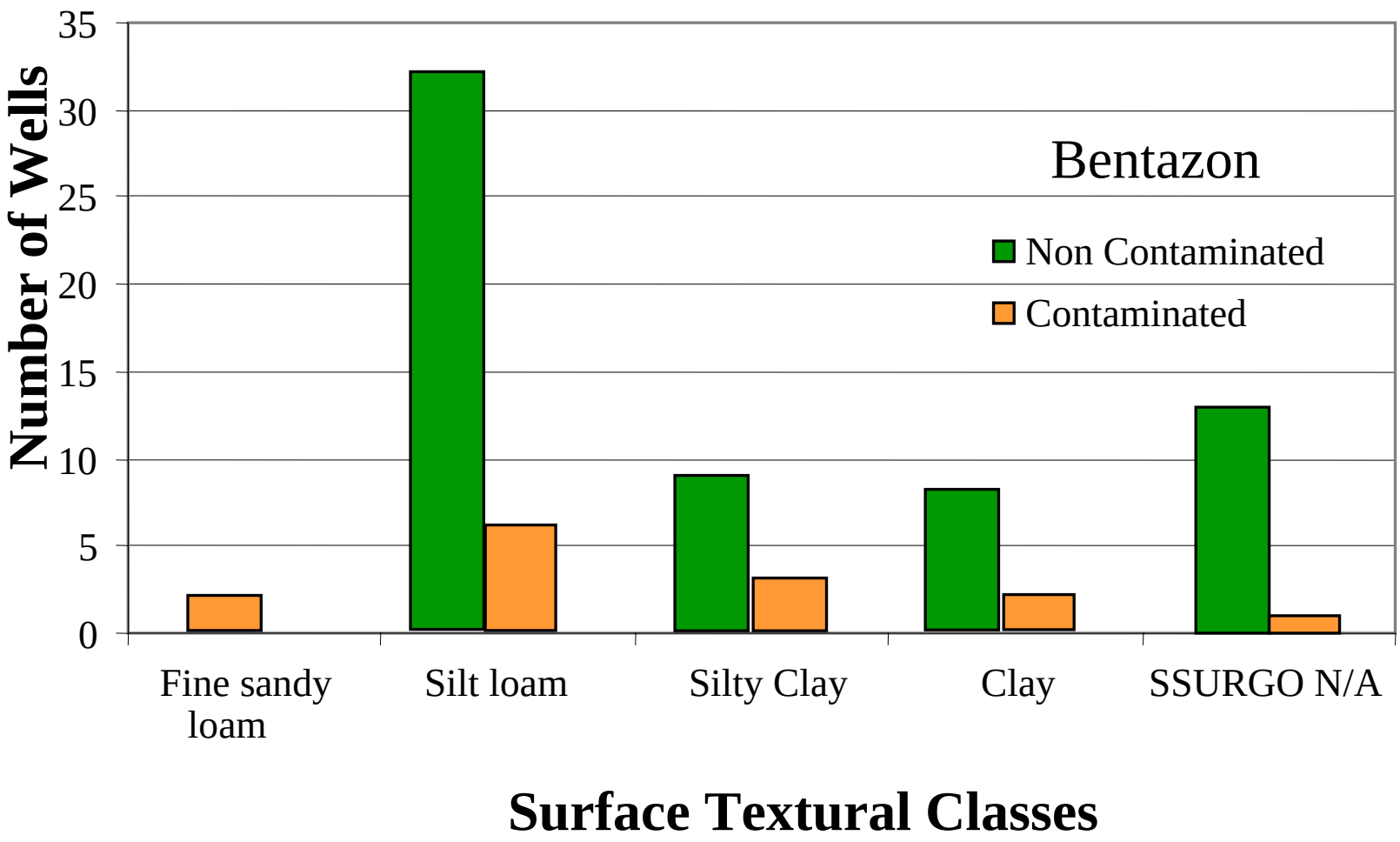


SSURGO: Surface Soil Texture

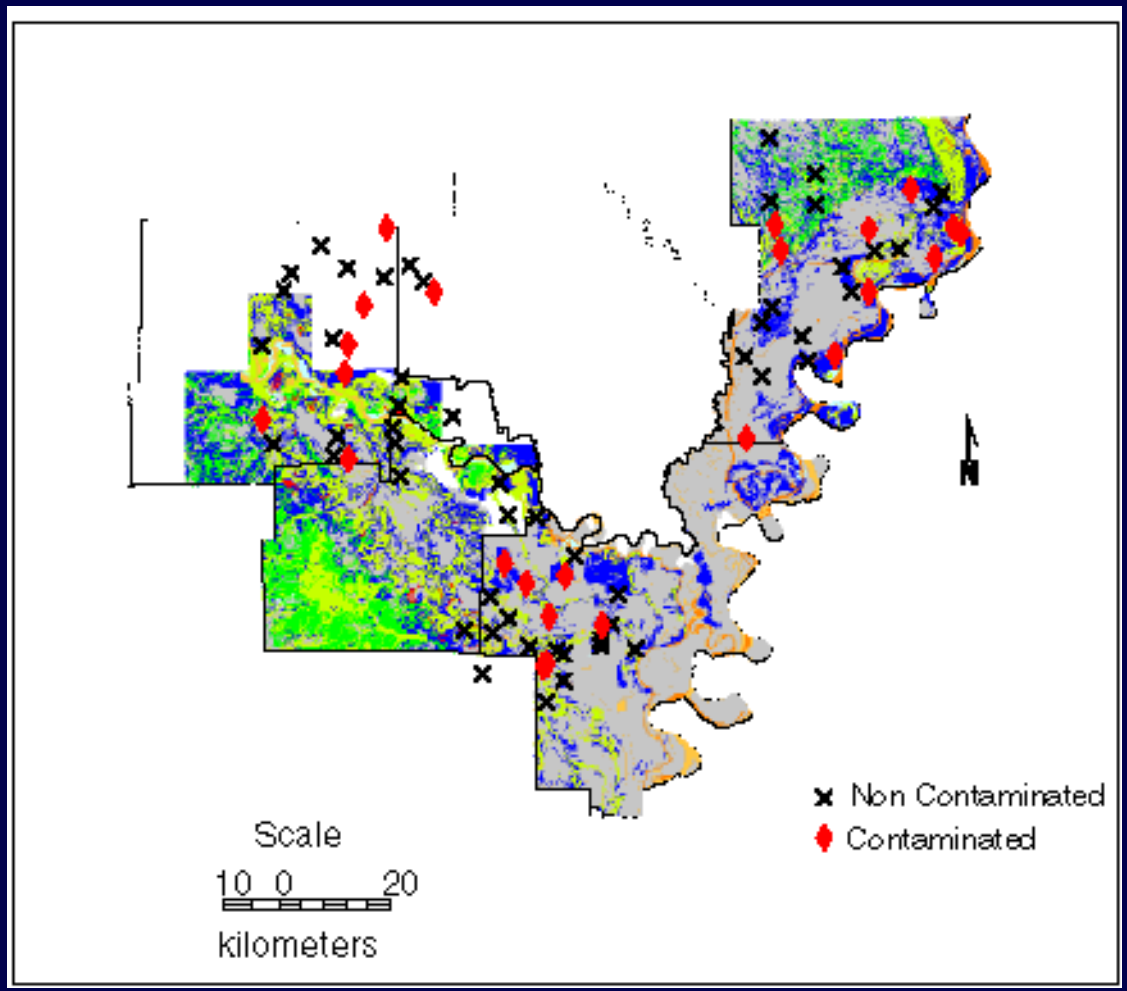


- Clay
- Silty clay
- Silt loam
- Silty clay
- Fine sandy loam

Presence of Bentazon vs. Surface Soil Texture

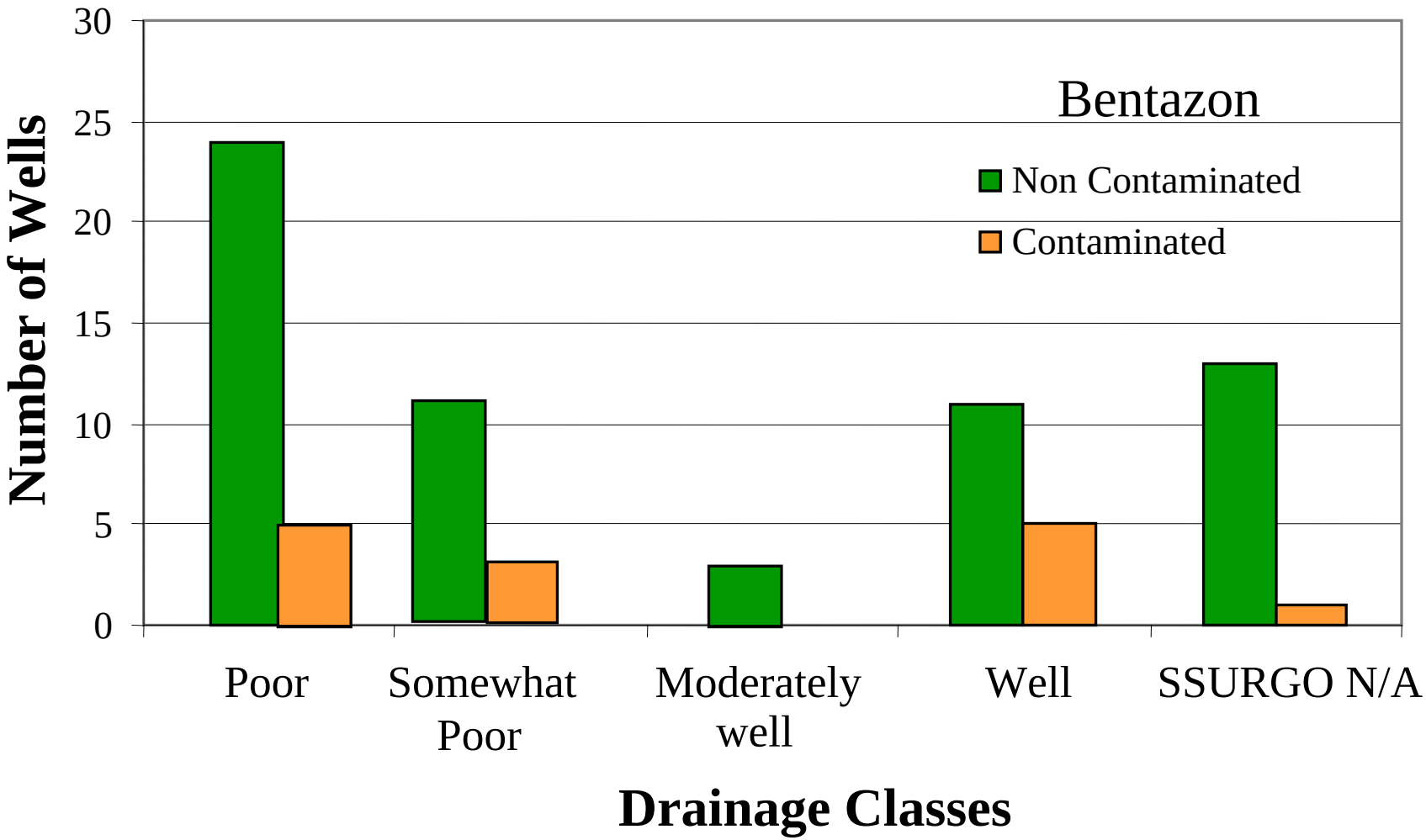


SSURGO: Soil Drainage Classes

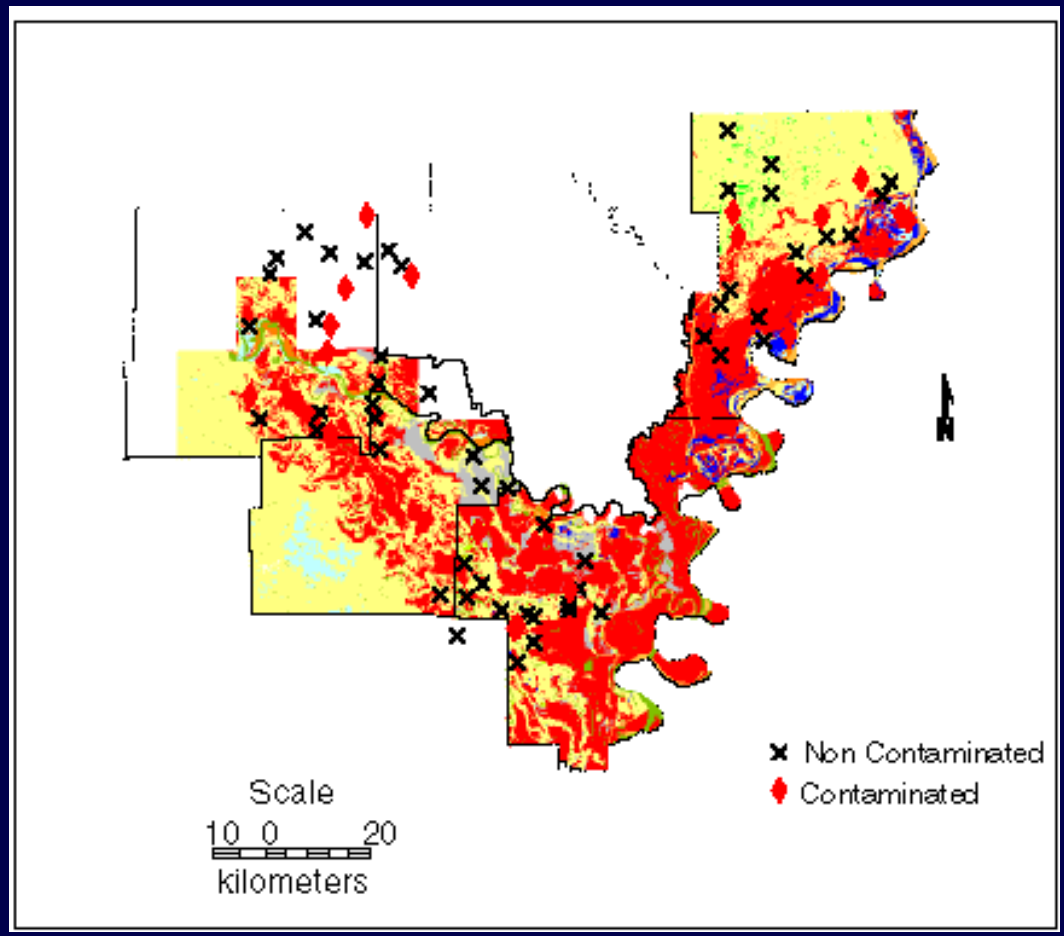


Very poor
Poor
Somewhat poor
Moderately well

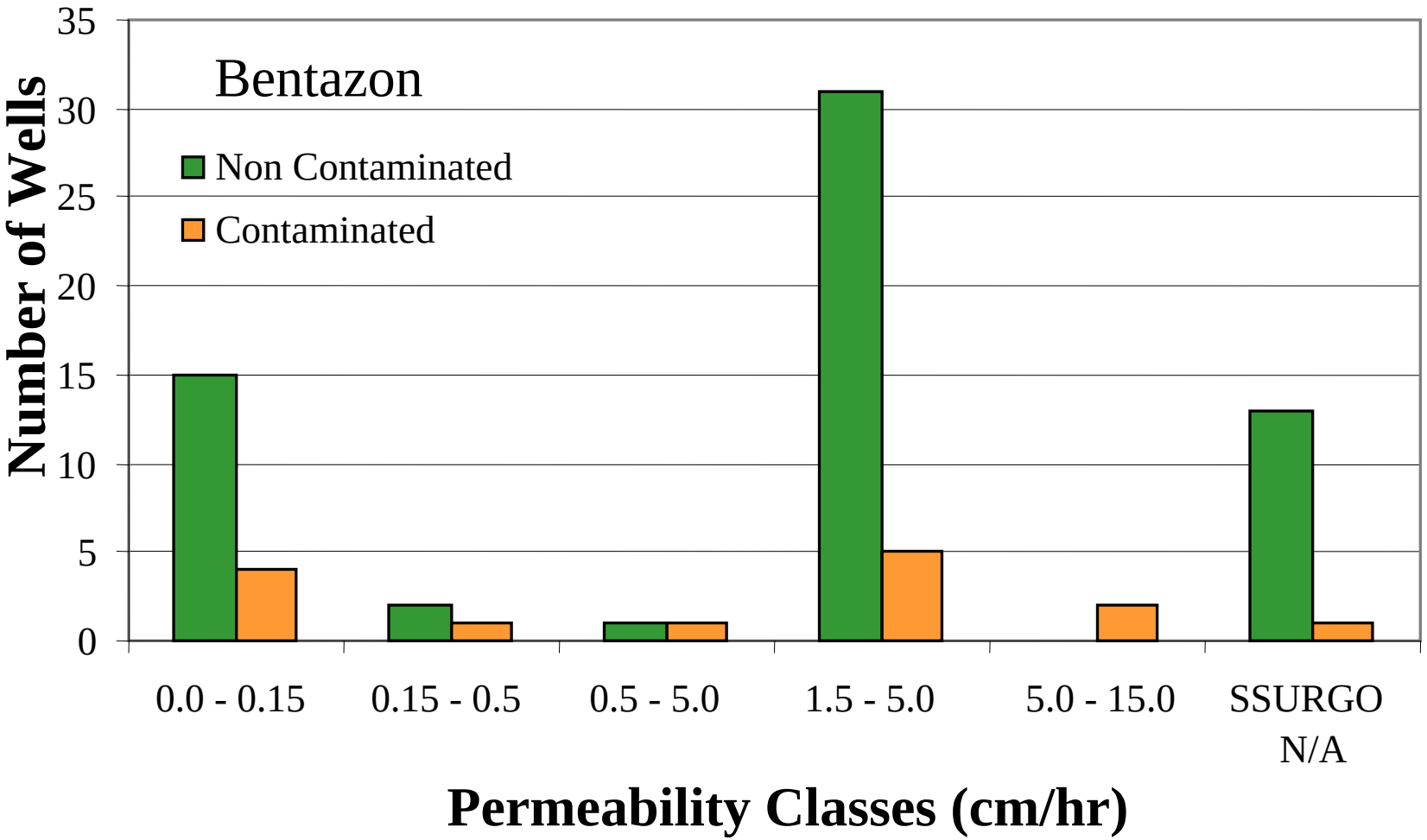
Presence of Bentazon vs. Soil Drainage Class



SSURGO: Soil Permeability Classes



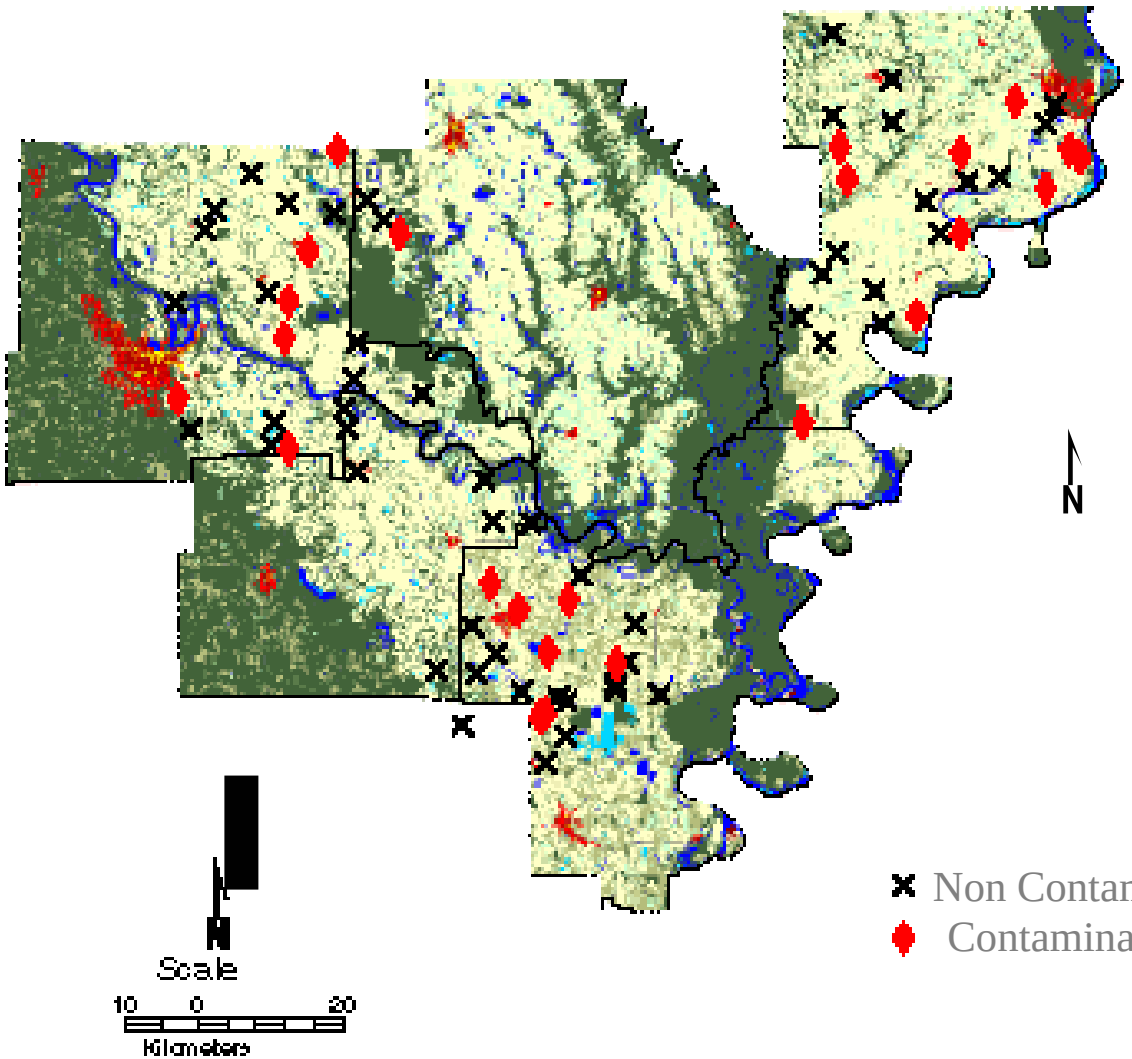
Presence of Bentazon vs. Soil Permeability Class



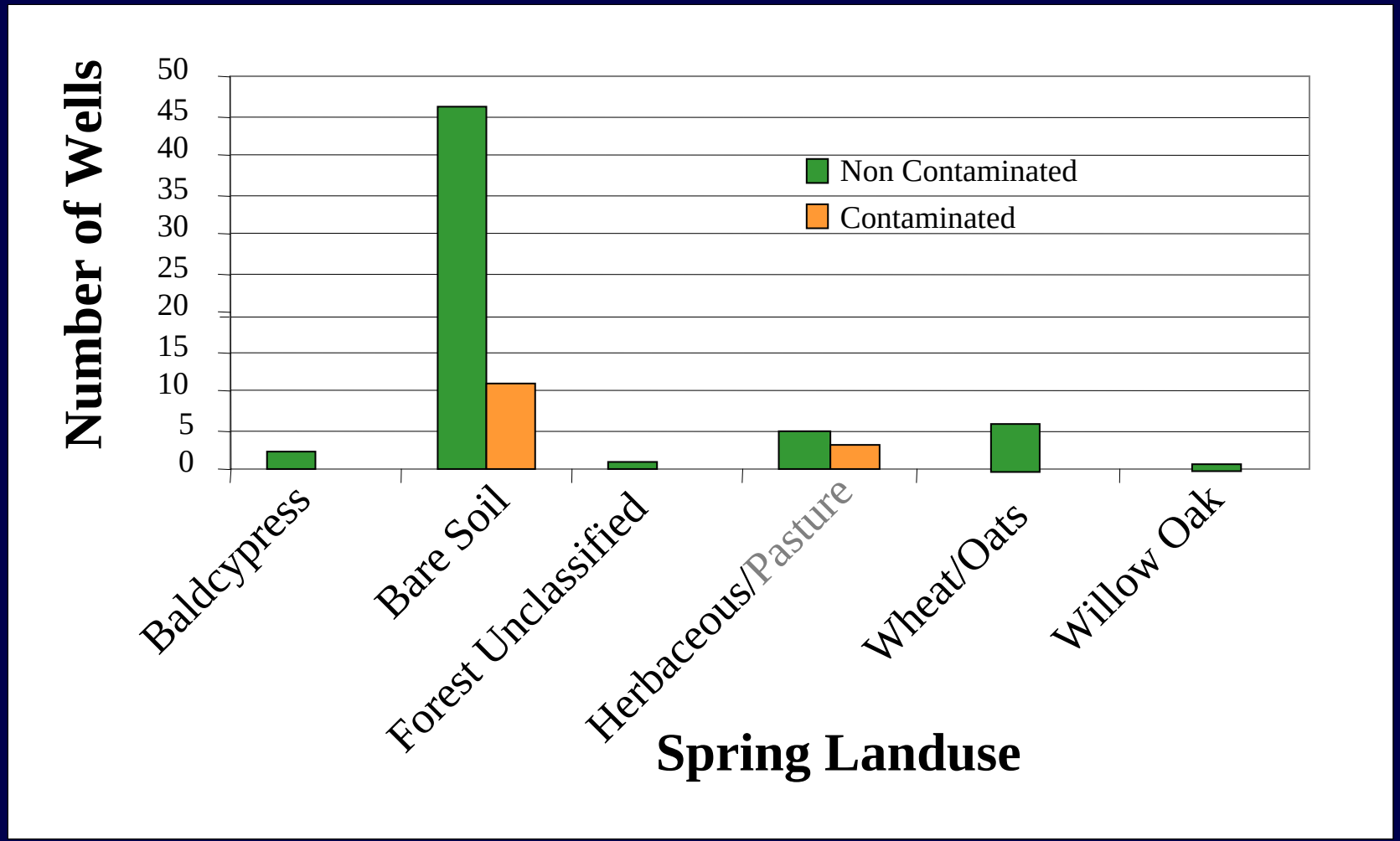
2000 Landuse Landsat TM

- Spring
- Summer

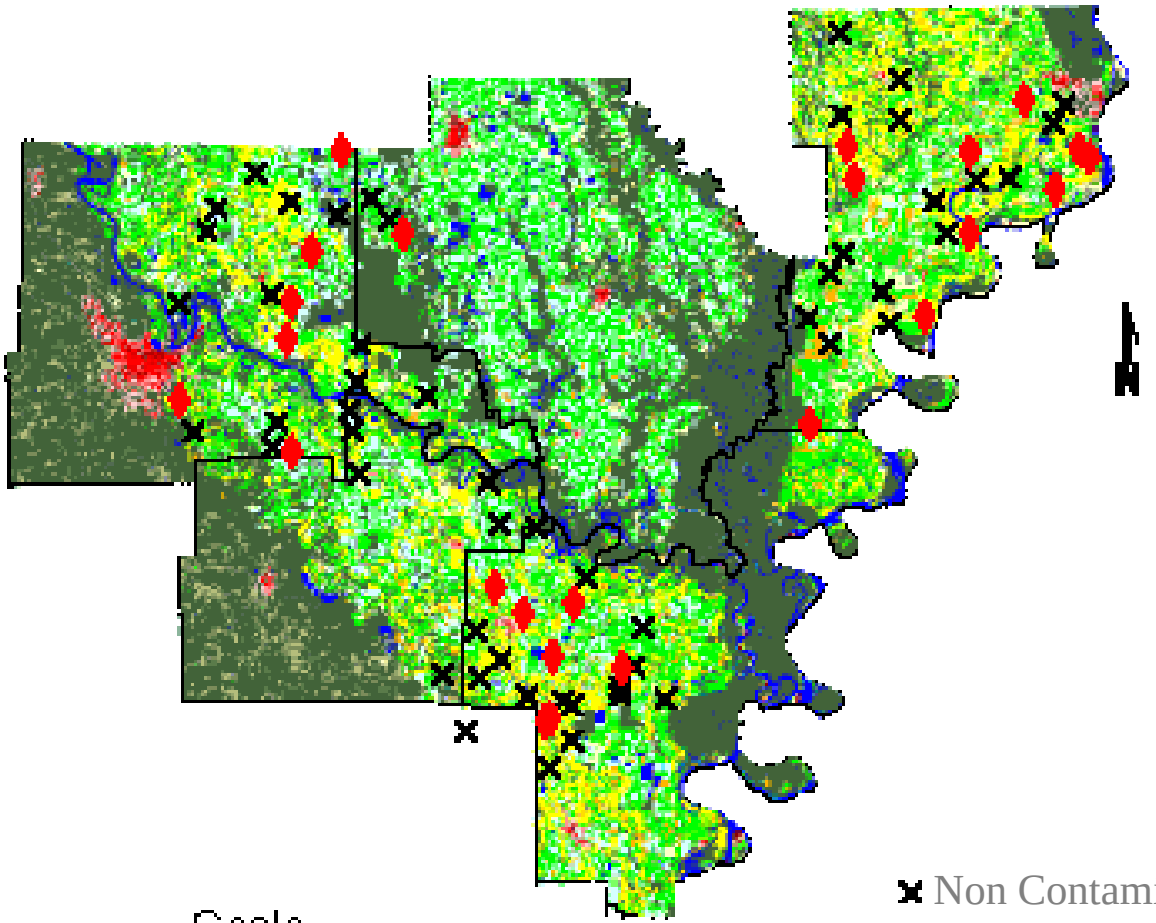
Spring Landuse



Presence of Bentazon vs. Spring Landuse

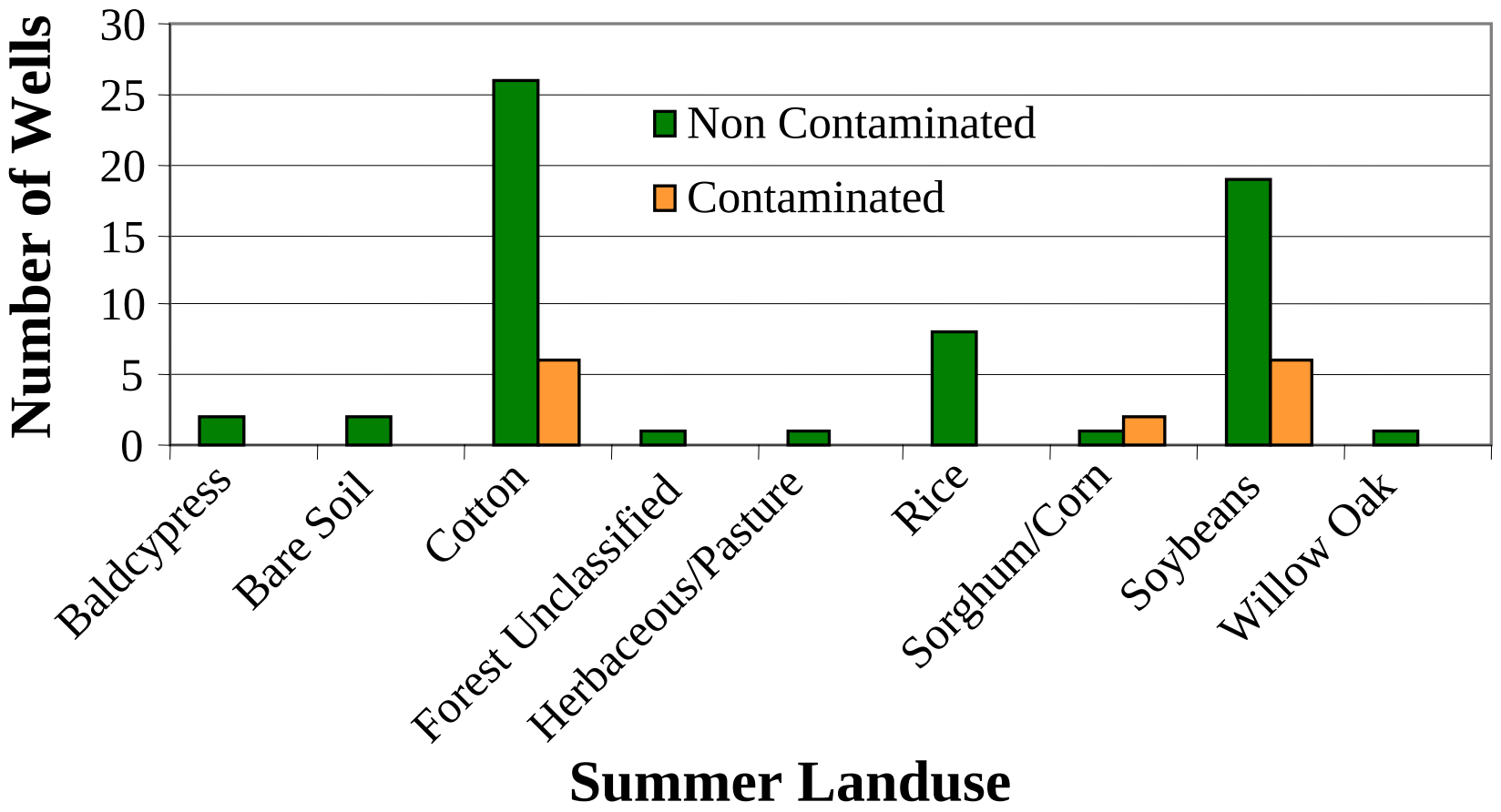


Summer Landuse

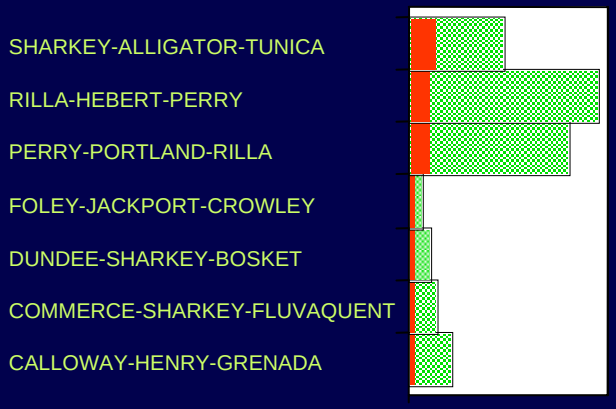


Urban
Cotton
Soybeans
Forest
Rice
Water

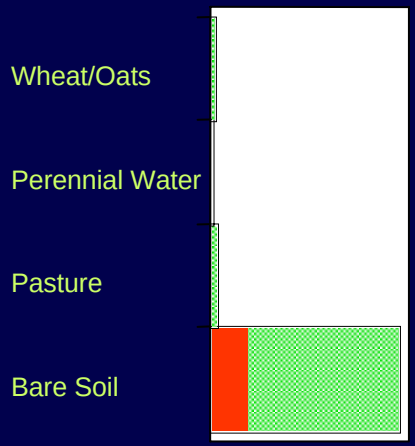
Presence of Bentazon vs. Summer Landuse



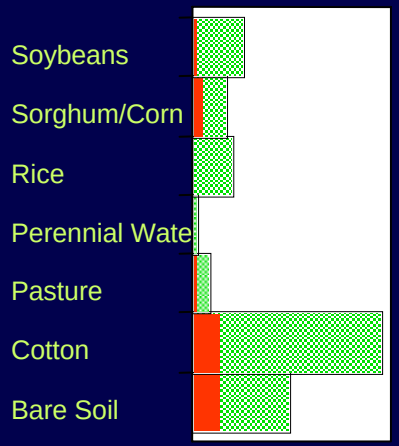
Presence of Bentazon vs. critical parameters within buffer zone



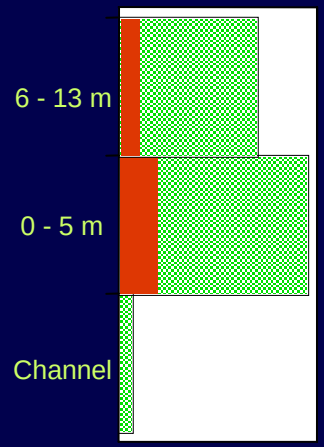
STATSGO Soil Associations



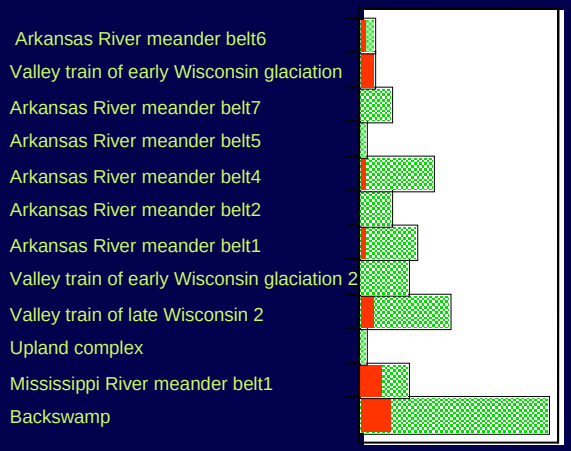
Spring Landuse



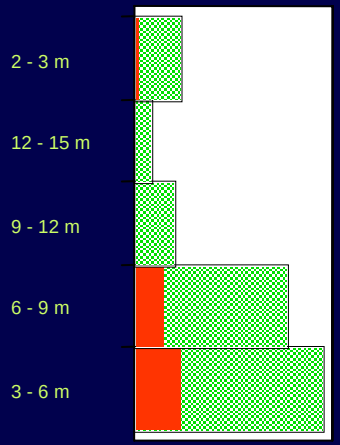
Summer Landuse



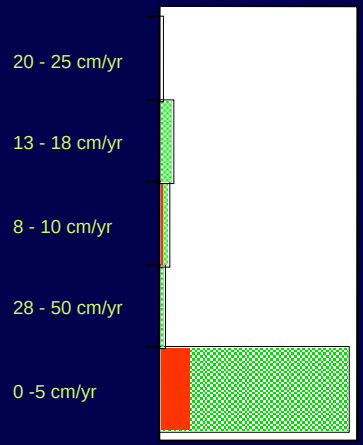
Depth to GW



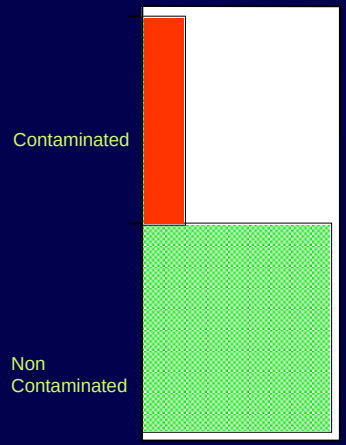
Geology



Thickness of claycap

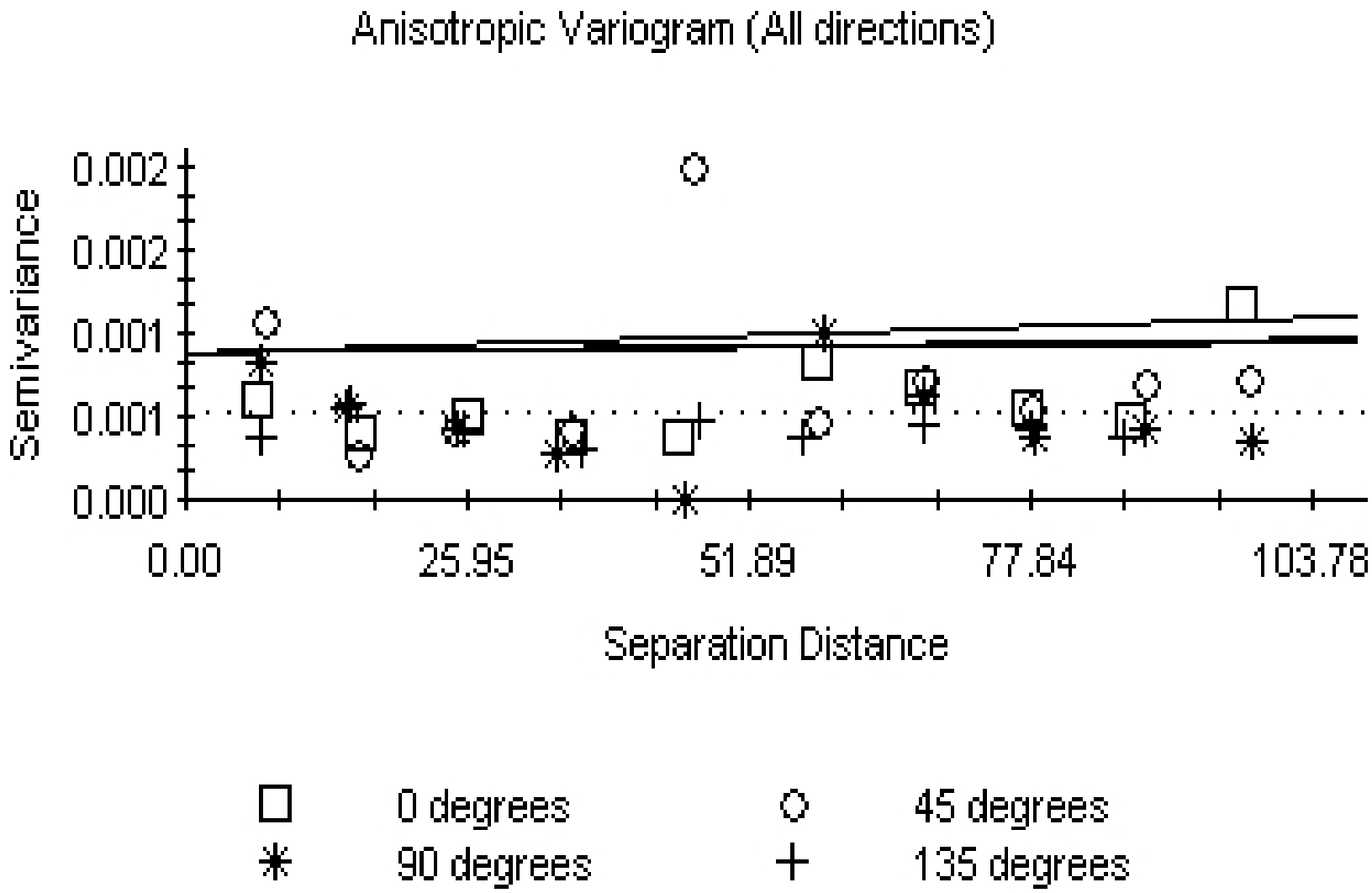


Recharge



Bentazon contamination

Geostatistics

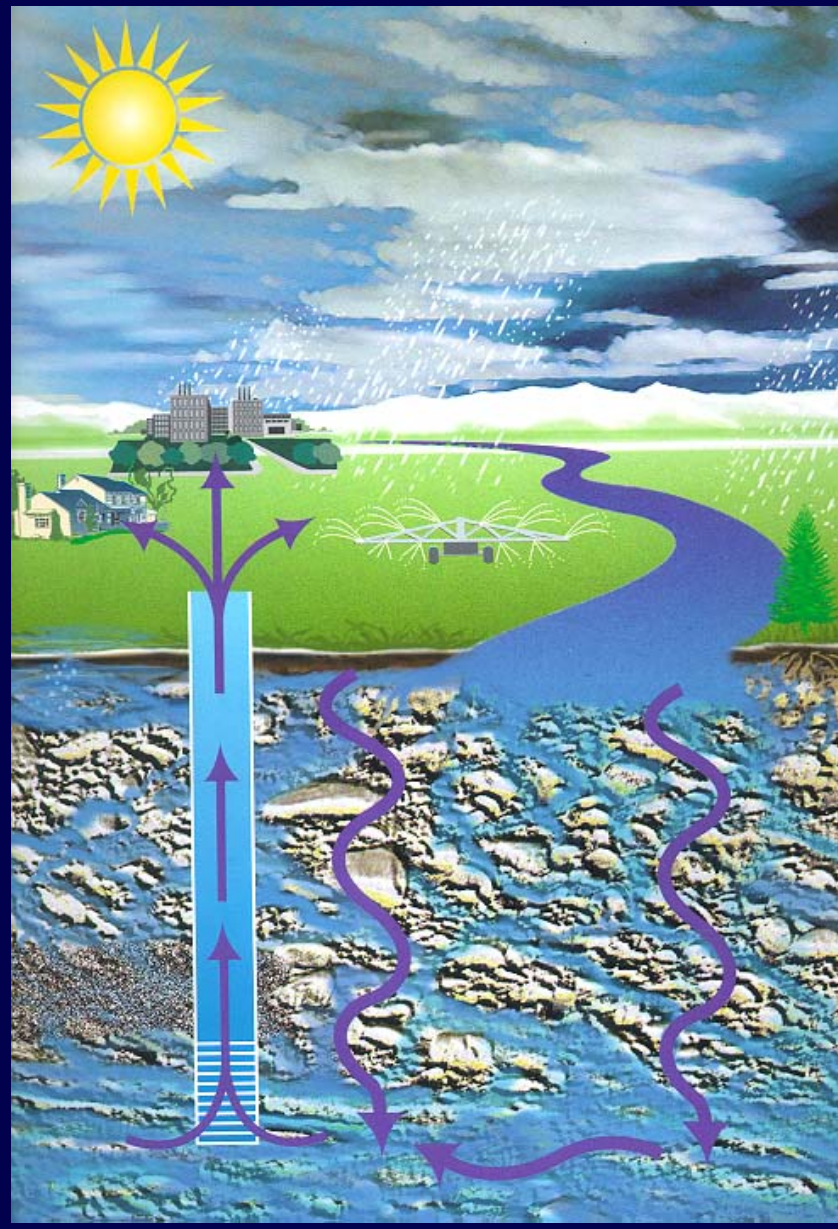


Conclusions

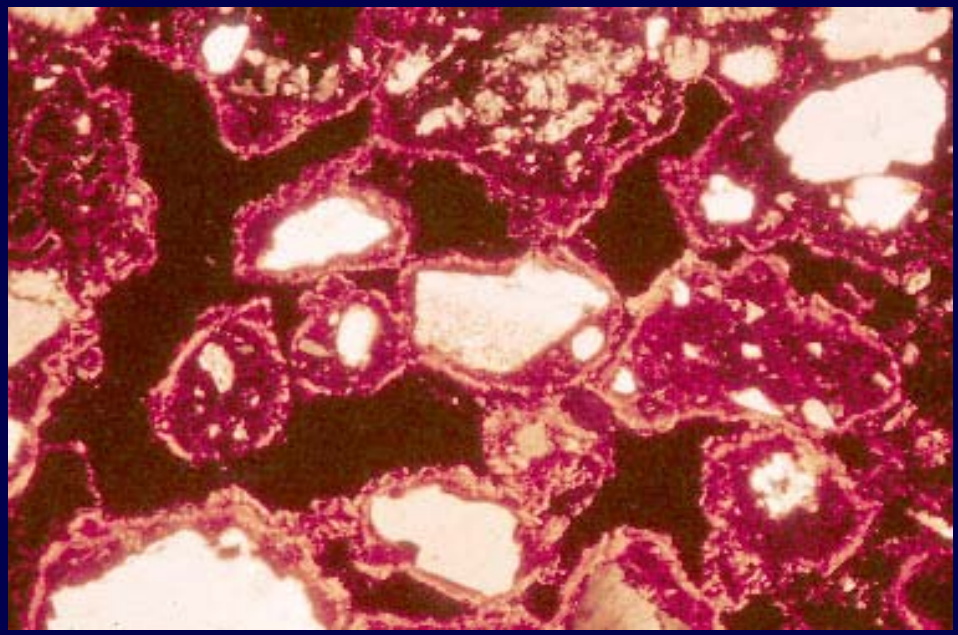
- Contamination coincided with
  - bare soil in spring
  - cotton and soybeans in summer
  - mostly coarser-textured soils
  - depth to GW of 0 - 5 m
  - backswmp
- No spatial correlation was found from semivariogram analyses

Conclusions cont….

- Each of the natural resource parameters has its own spatial distribution which affects spatial variability of well contamination
- Further studies needed
  - Data Layers (soil structure, bulk density, Ksat)
  - Methodology (e.g. neural networks)



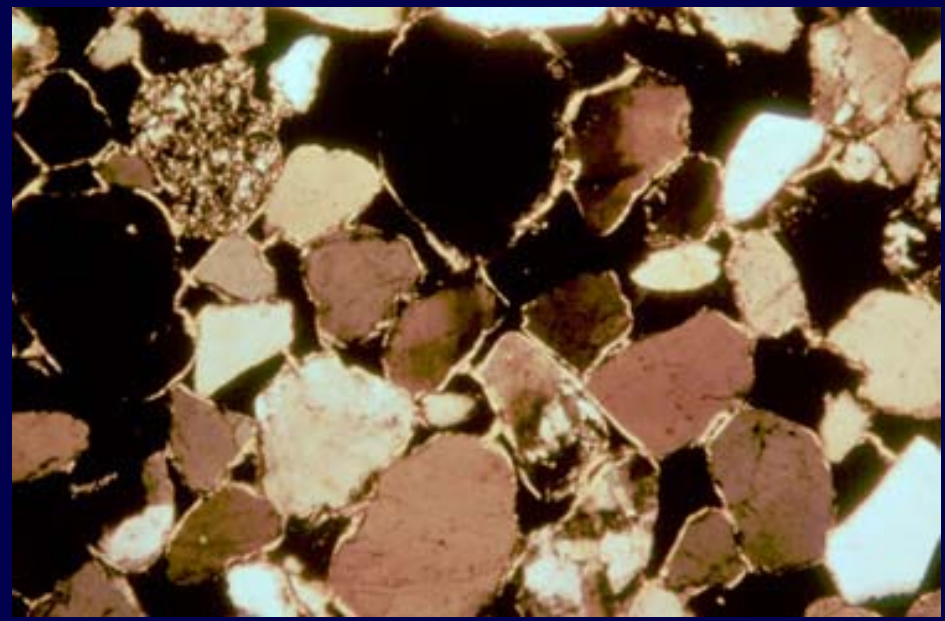
Courtesy: Nofzinger et al, CLMS model

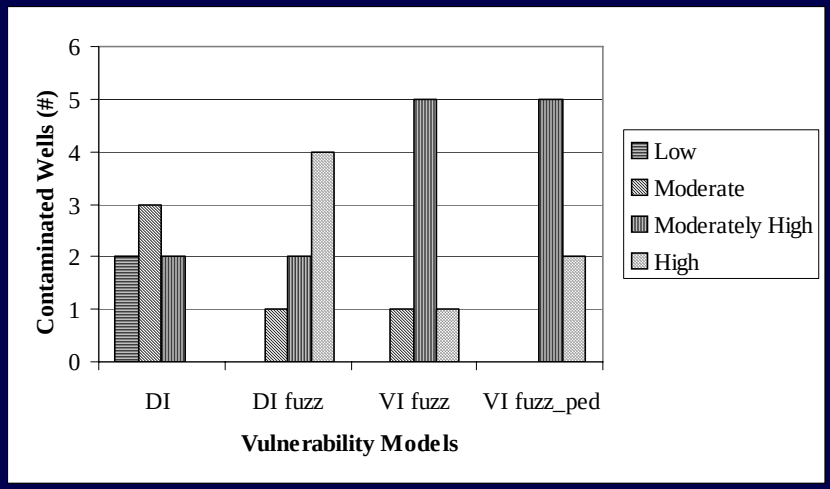


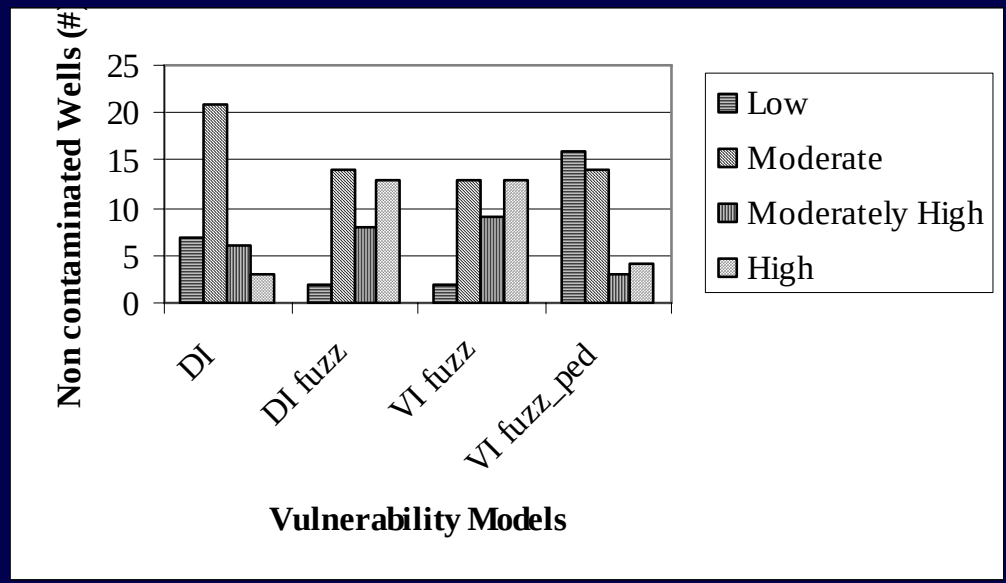
How do we incorporate this layer in the model??

Hydropedology ? New Branch of Study??

Photomicrograph of a thin section




Contaminated Wells (#)
6
5
4
3
2
1
0
DI
DI fuzz
VI fuzz
VI fuzz_ped
Vulnerability Models
Low
Moderate
Moderately High
High


Non contaminated Wells (#)
25
20
15
10
5
0
DI
DI fuzz
VI fuzz
VI fuzz_ped
Vulnerability Models
Low
Moderate
Moderately High
High