Delineation of Ground water Vulnerability to Agricultural Contaminants using Neuro-fuzzy Techniques

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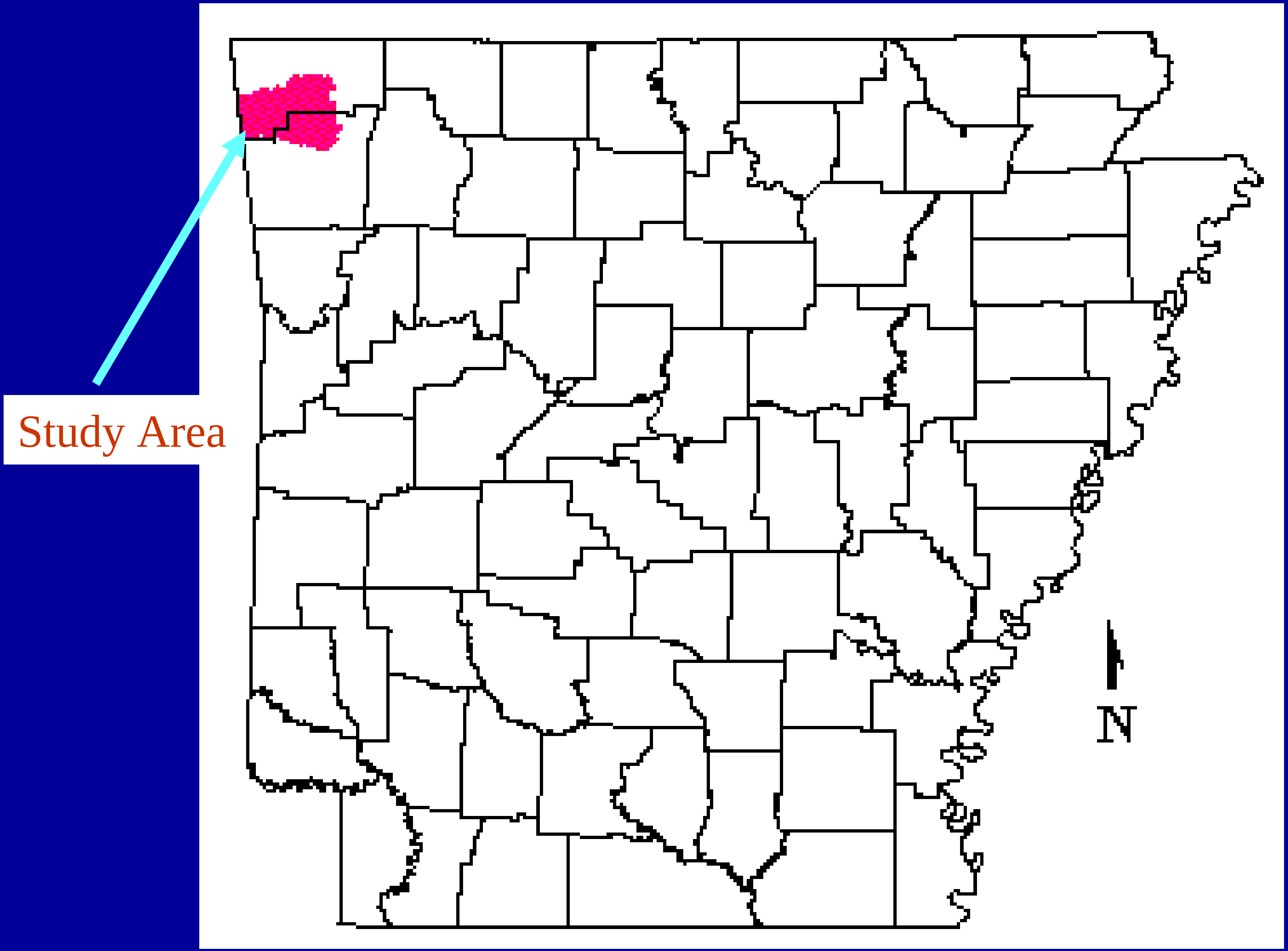
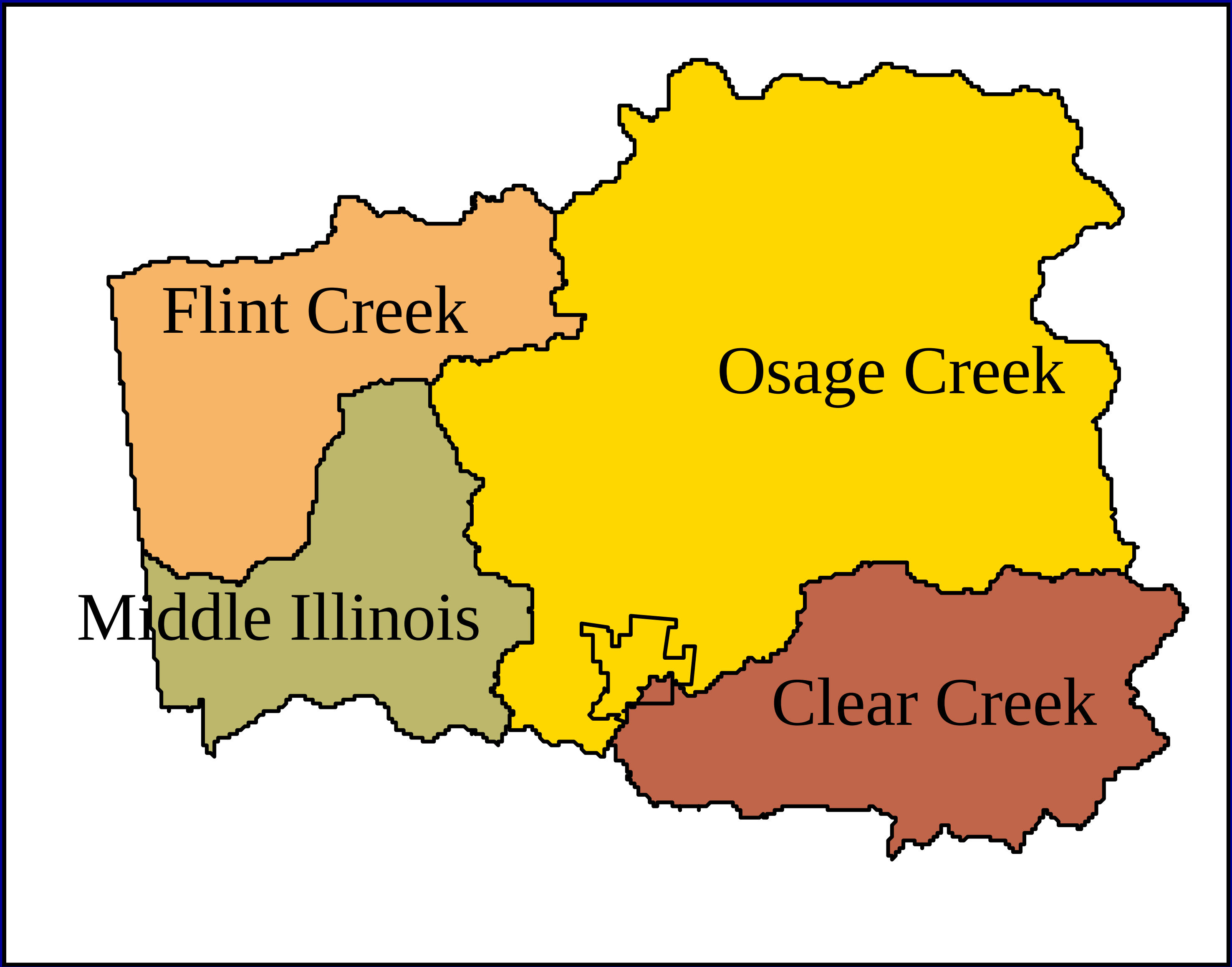
Introduction

- Delineation of vulnerable areas and selective applications of animal wastes/fertilizer in those areas can minimize contamination of ground water (GW).
- However, assessment of GW vulnerability or delineation of the monitoring zones is not easy since uncertainty is inherent in all methods of assessing GW vulnerability


Study Area
N

Location of the Major Watersheds



Sources of Uncertainties

- Errors in obtaining data
- The natural spatial and temporal variability of the hydrogeologic parameters in the field
- The numerical approximation and computerization

Characteristics of the Models

- Capability to deal with uncertainties
- Tolerate imprecision
- Extract information from incomplete data sets
- Incorporate expert’s opinion directly into the model
- Regional Scale
- The models use existing data bases
- Integrated in a GIS

Specific Objectives

- Integrate the Neuro-fuzzy techniques in a GIS platform to predict ground water vulnerability in a large watershed

Primary Data Layers Used

- Watershed Boundaries
- Location of springs/wells
- Water quality
- Geology
- Soils
- Landuse and landcover (LULC)*
- DEMs

* model inputs

Secondary Data Layers Used

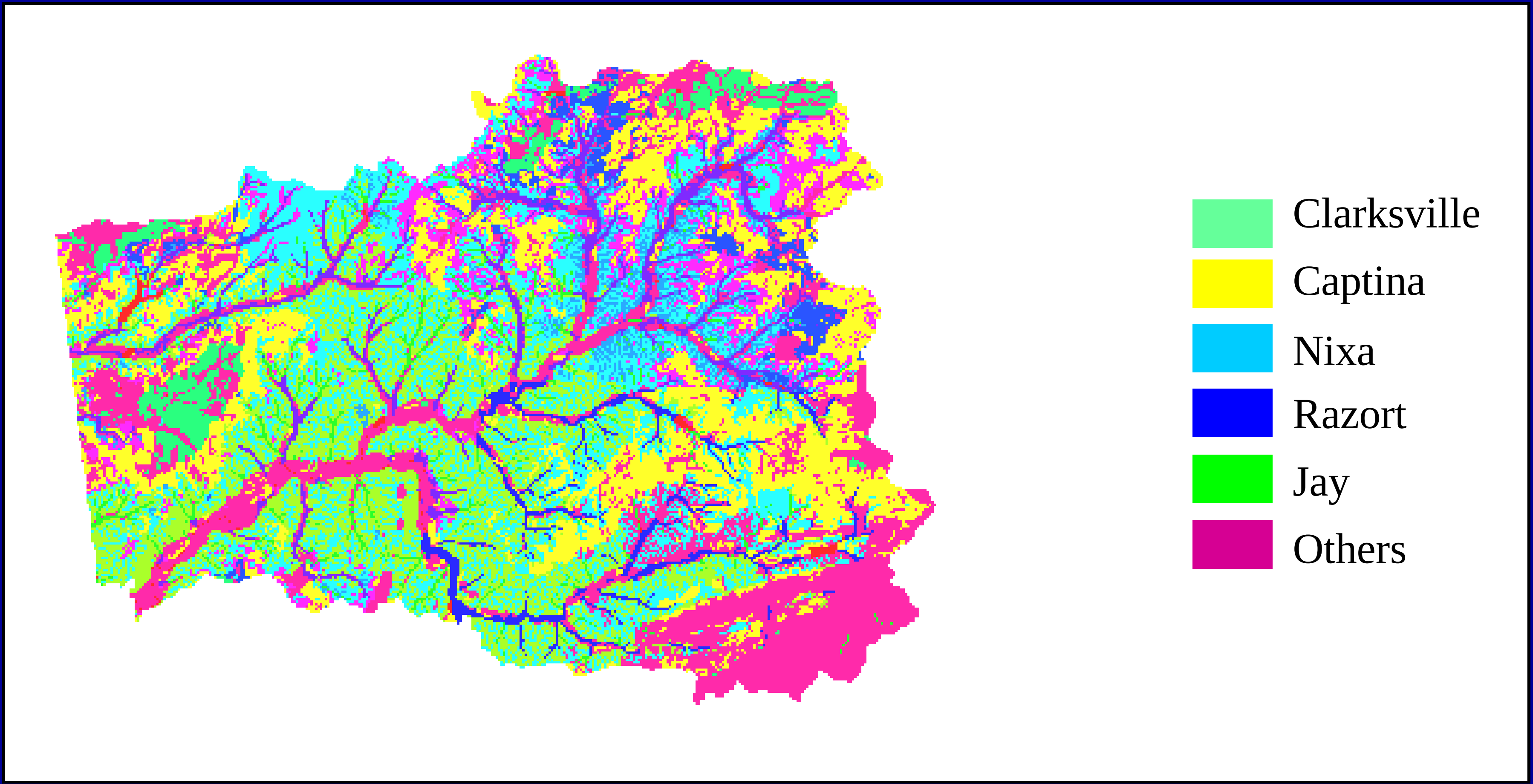
- Soil hydrologic group*
- Soil structure (pedality points)*
- Depth of the soil profile* (excluding Cr and R)
- Slopes
- Elevation

* model inputs

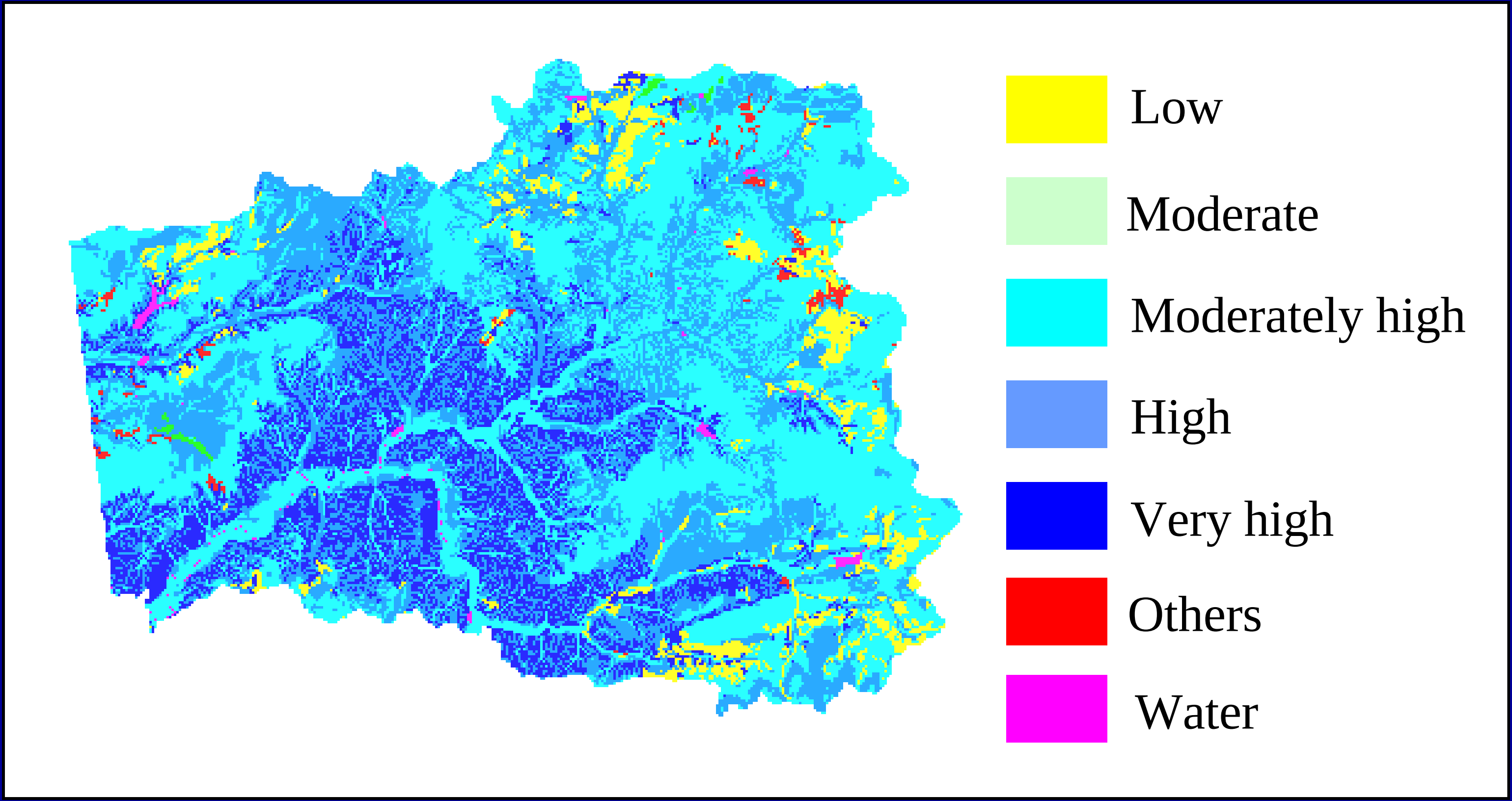
Description of the Input Data Layers

Data	Scale/resolution	Comments
Soil	1:24,000	NRCS
Location of springs/wells	Field	GPS
Water quality data	Field	ADEQ and AWRC
LULC	30 m/ 2ha	CAST

Spatial Distribution of Major Soil Series

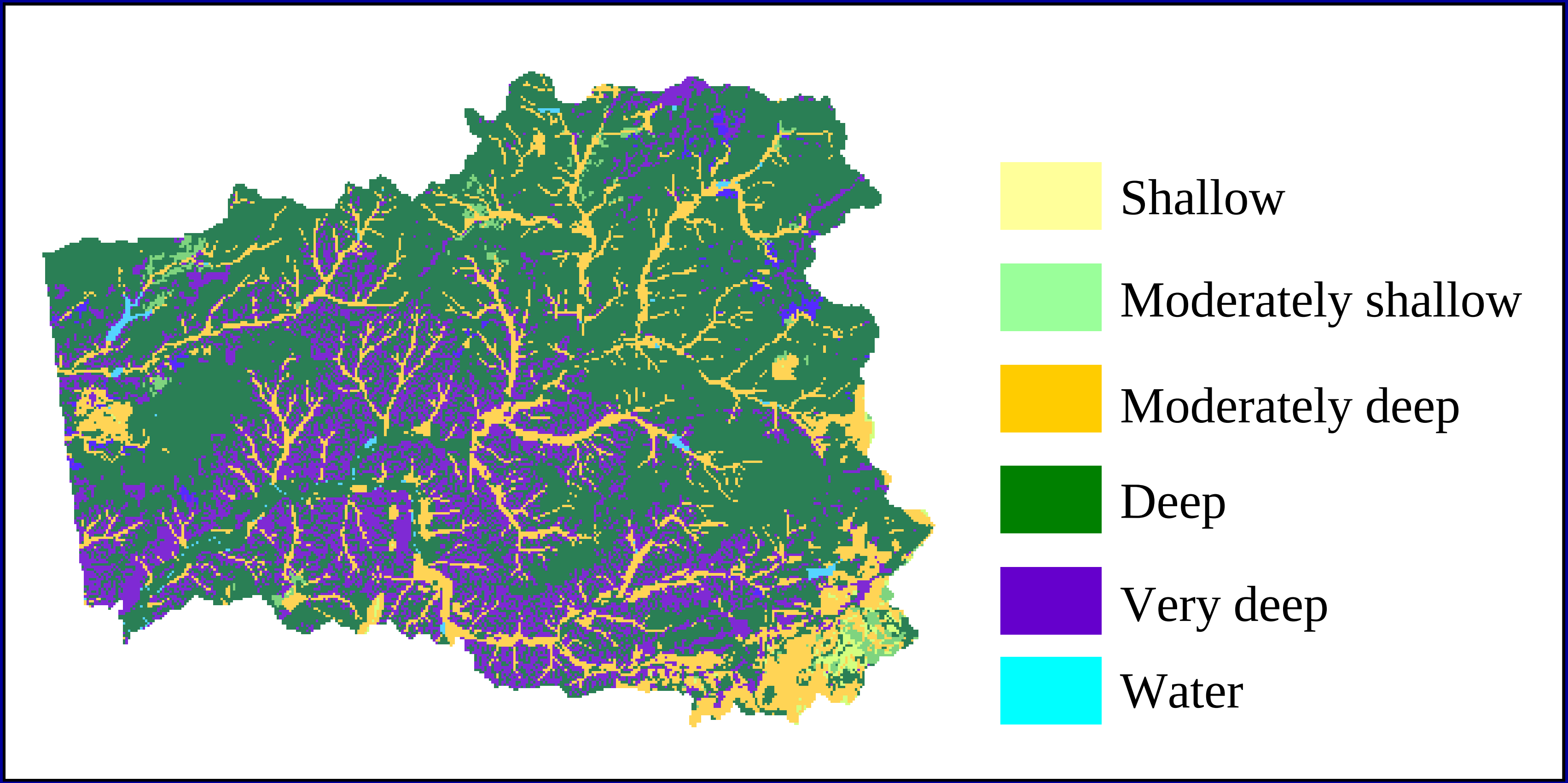


Spatial Distribution of Soil Structure (Pedality Points)



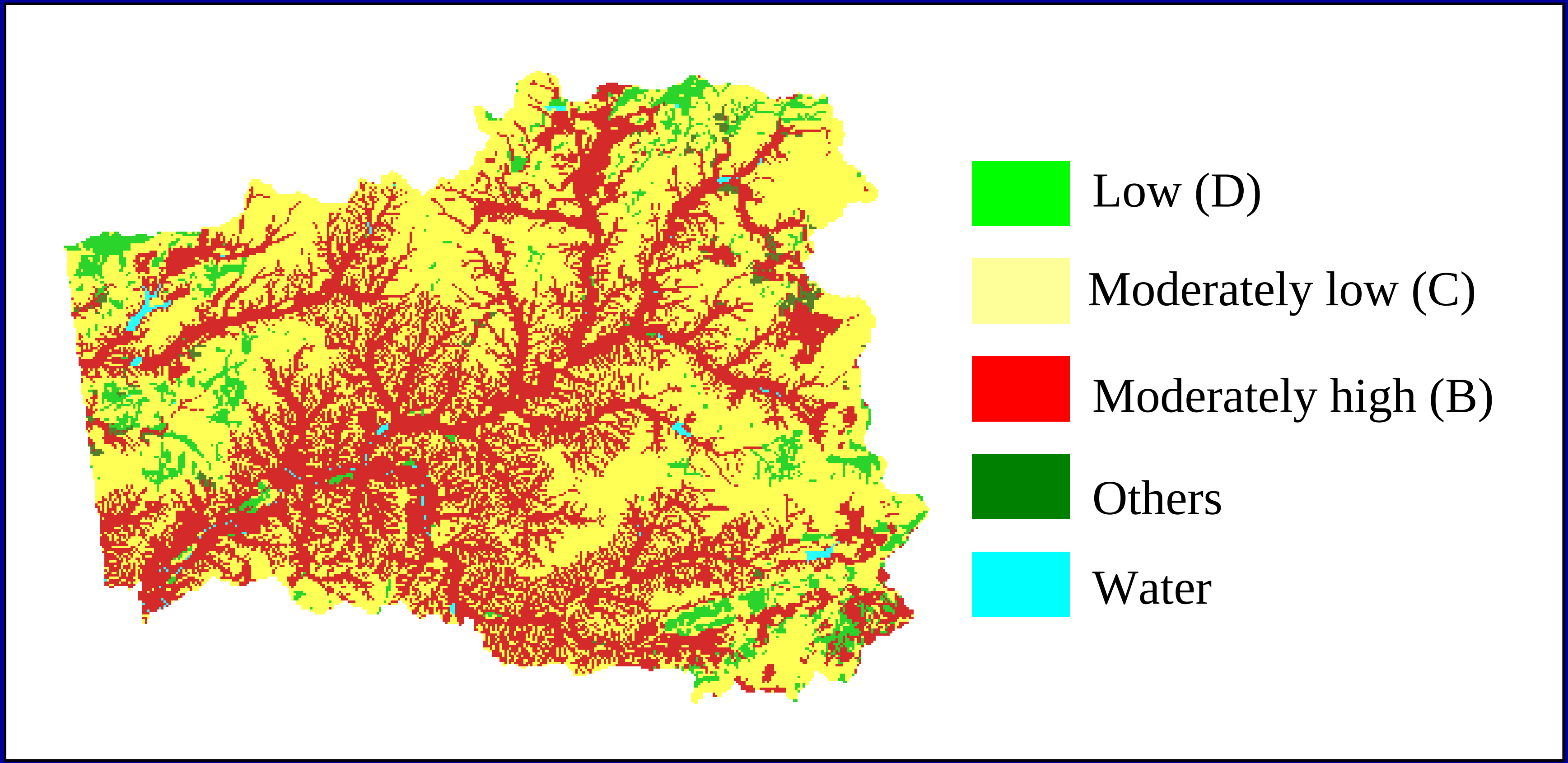
Low = 14 – 17, Moderate = 20 – 30, Moderately high= 31 – 40, High = 40 – 50 and very high> 51

Spatial Distribution of Soil Profile Depth

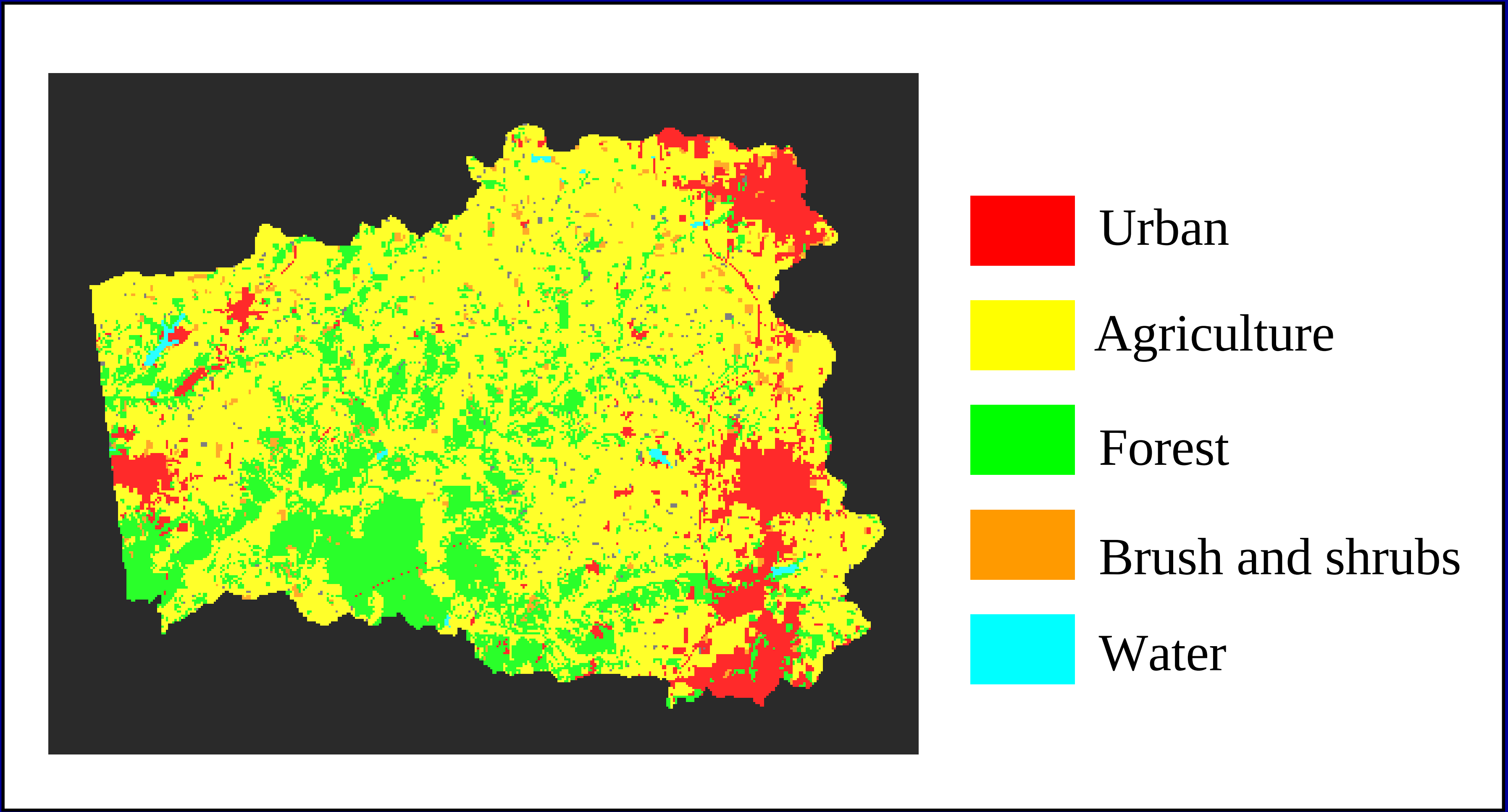


Depth (inches) : Shallow = 9 – 30, Moderately shallow = 31 – 50, Moderately deep = 51 – 69, Deep = 70 – 85 and Very Deep = > 85

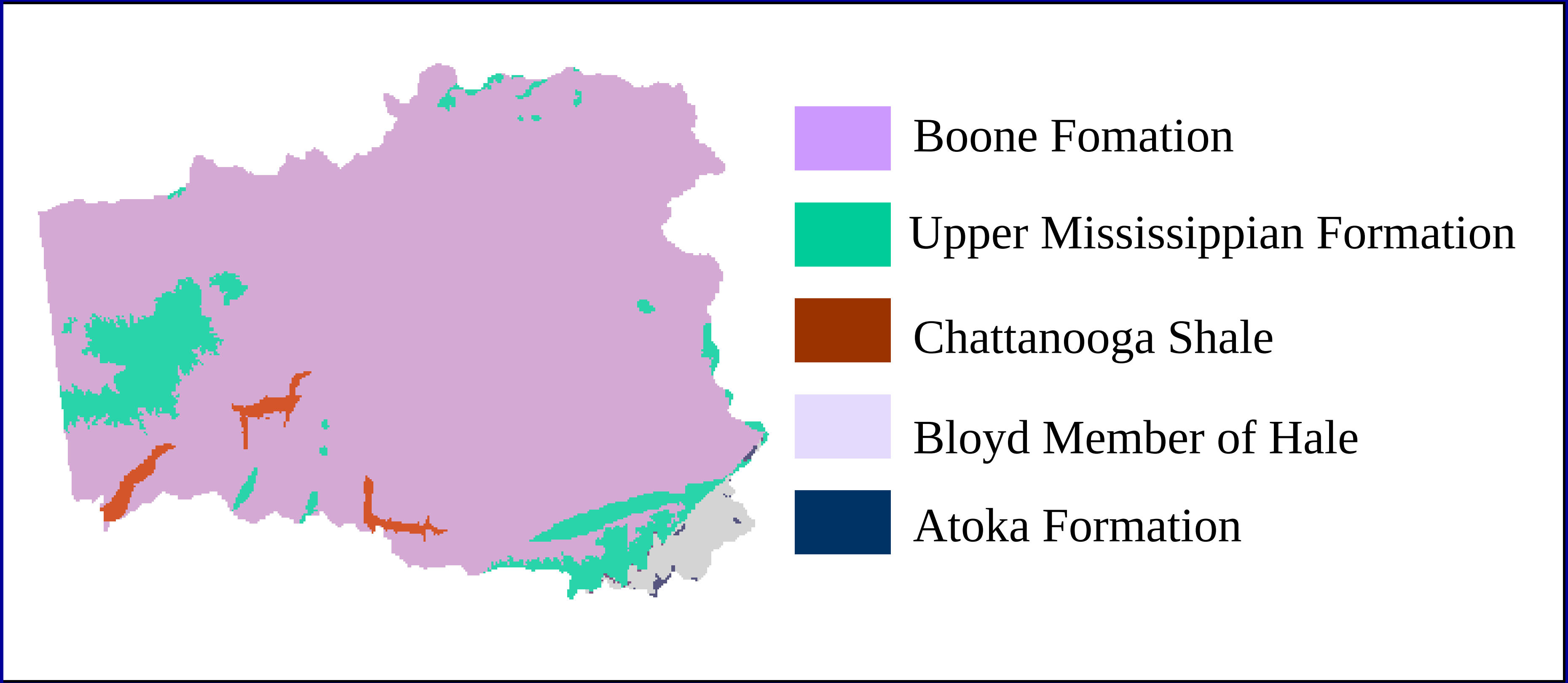
Spatial Distribution of Soil Hydrologic Groups



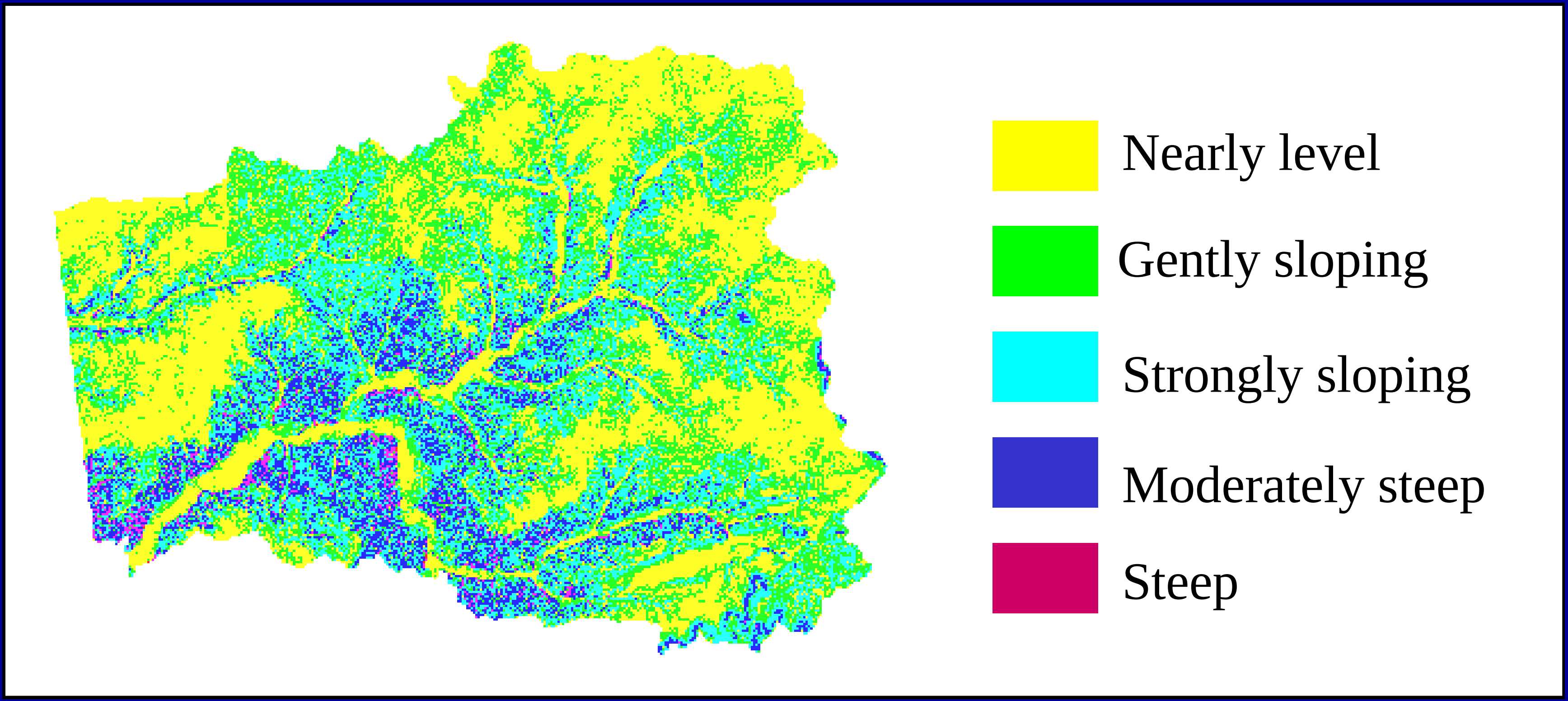
Spatial Distribution of Landuse



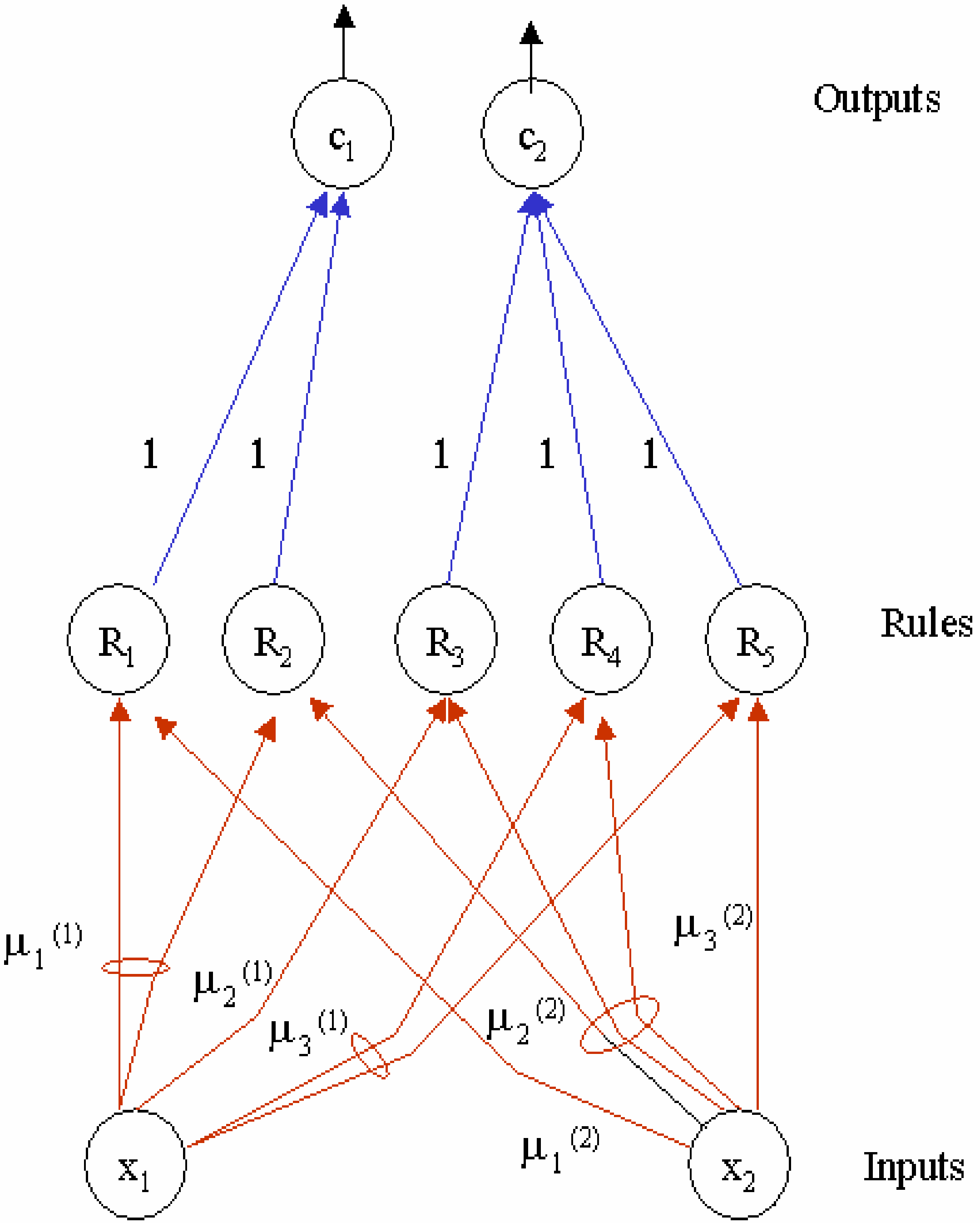
Spatial Distribution of Geology



Spatial Distribution of Slopes



Neruo-fuzzy Approach



Necessary steps

- Training data
- Testing data

Why hybrid?

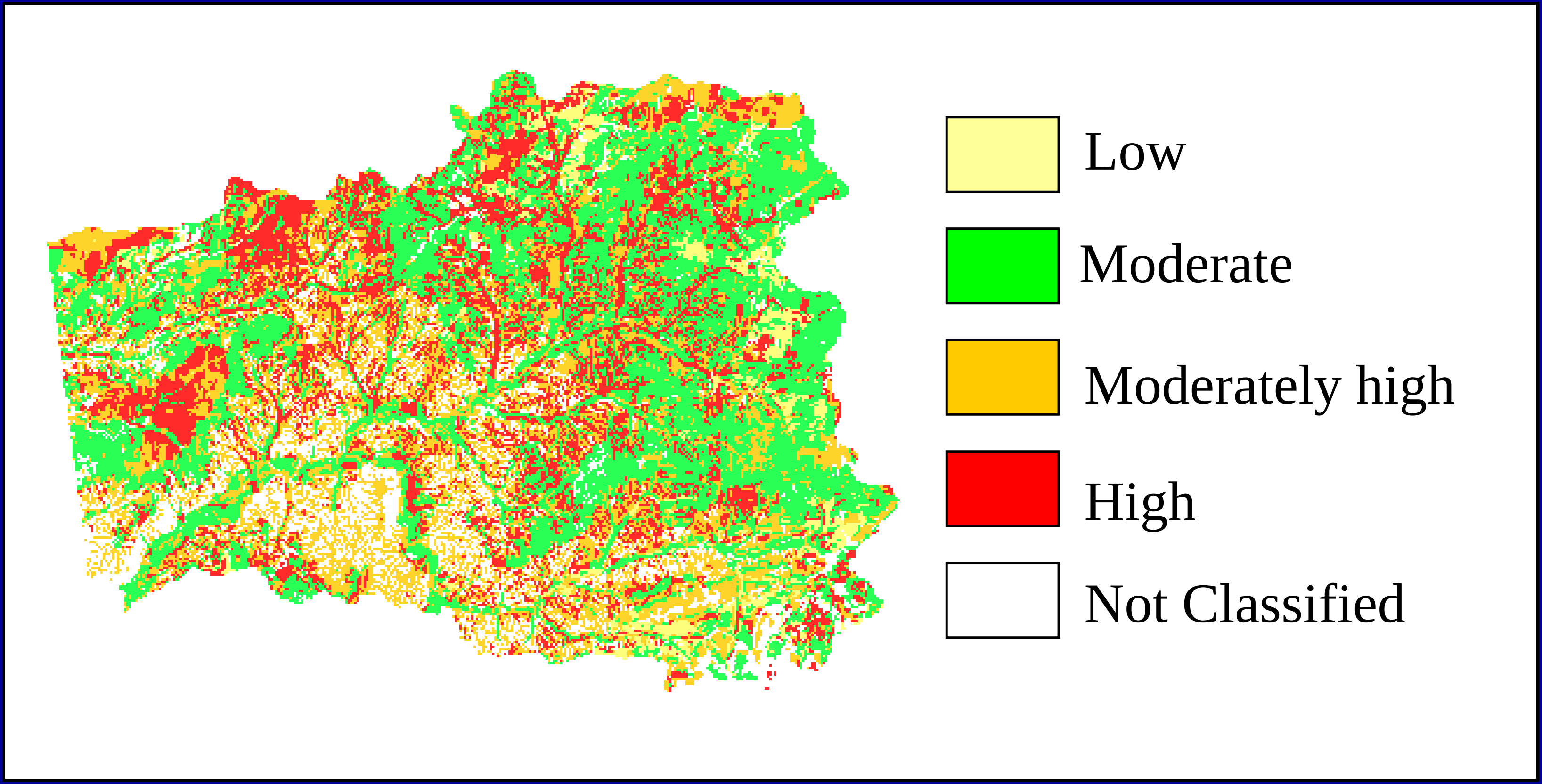
- Schultz and Wieland (1997) suggested that NN could parsimoniously represent non-linear systems and seem to be robust and flexible under data driven situations and allow deeper professional insight into the model.
- Fuzzy logic provides an opportunity to incorporate experts' opinion and robust under uncertainty.

Assessment of Models

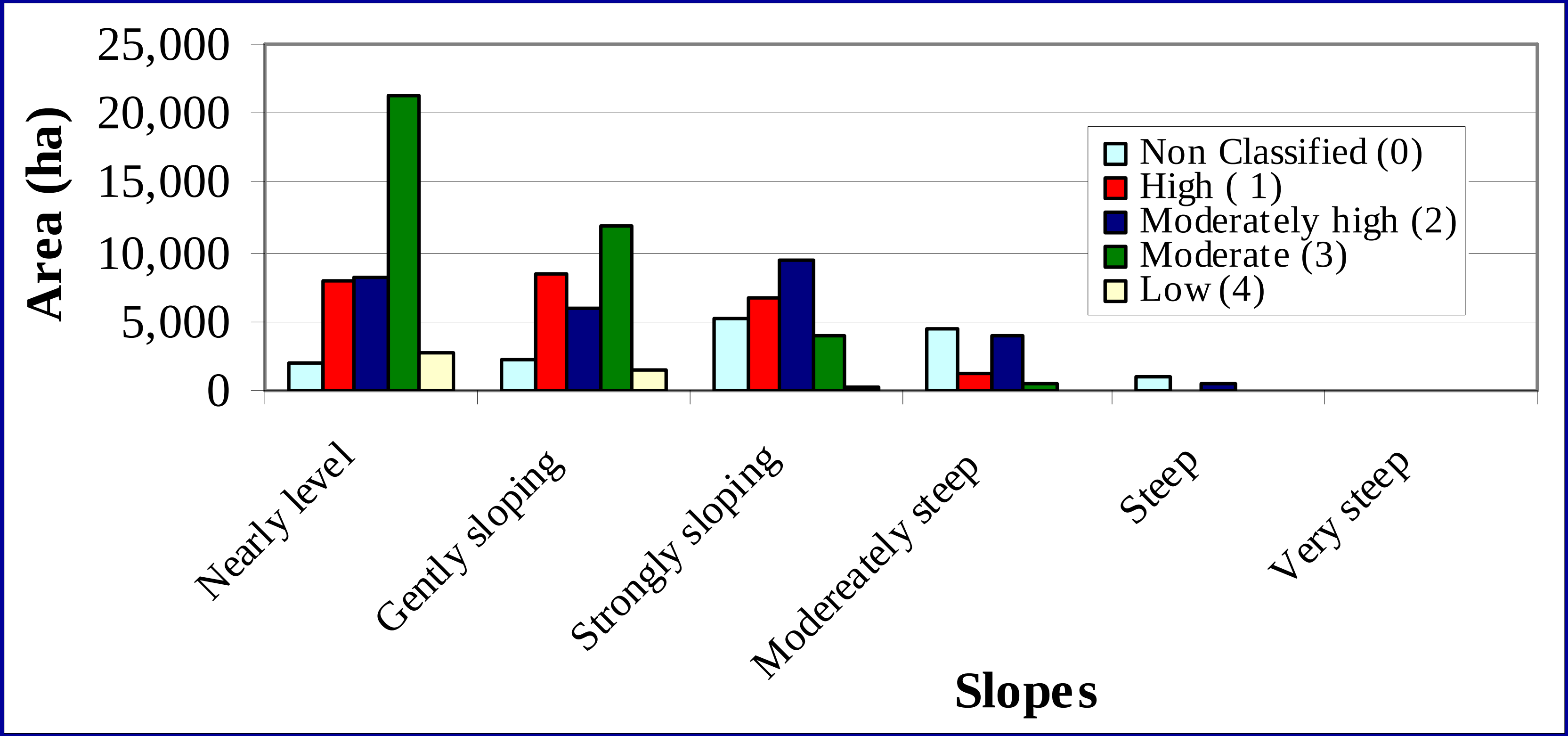
- Comparison of models and Field data
  - Coincidence analyses
  - Coincidence with inputs

Results and Discussion

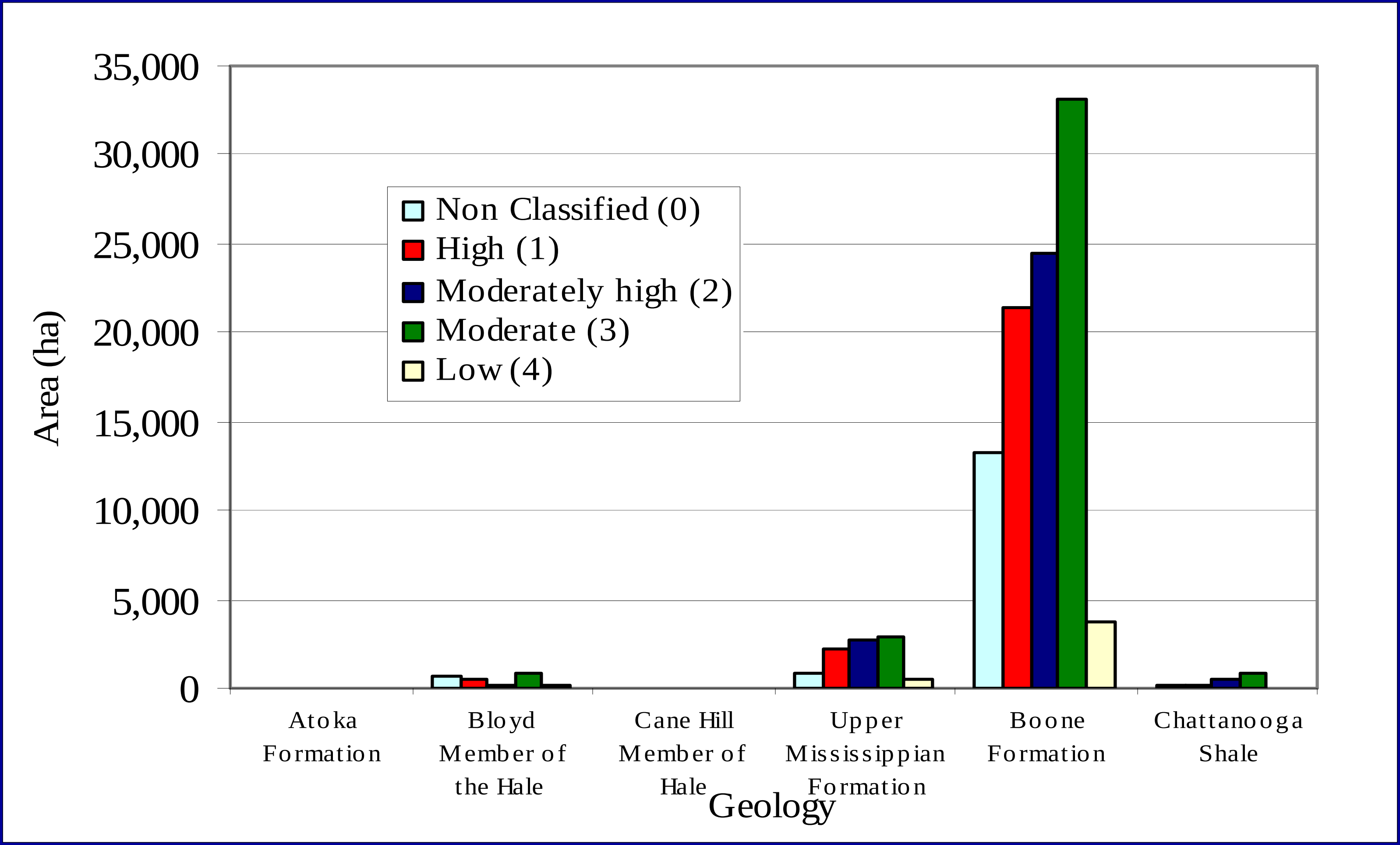
Spatial Distribution of Vulnerability from the Preliminary Neuro-Fuzzy



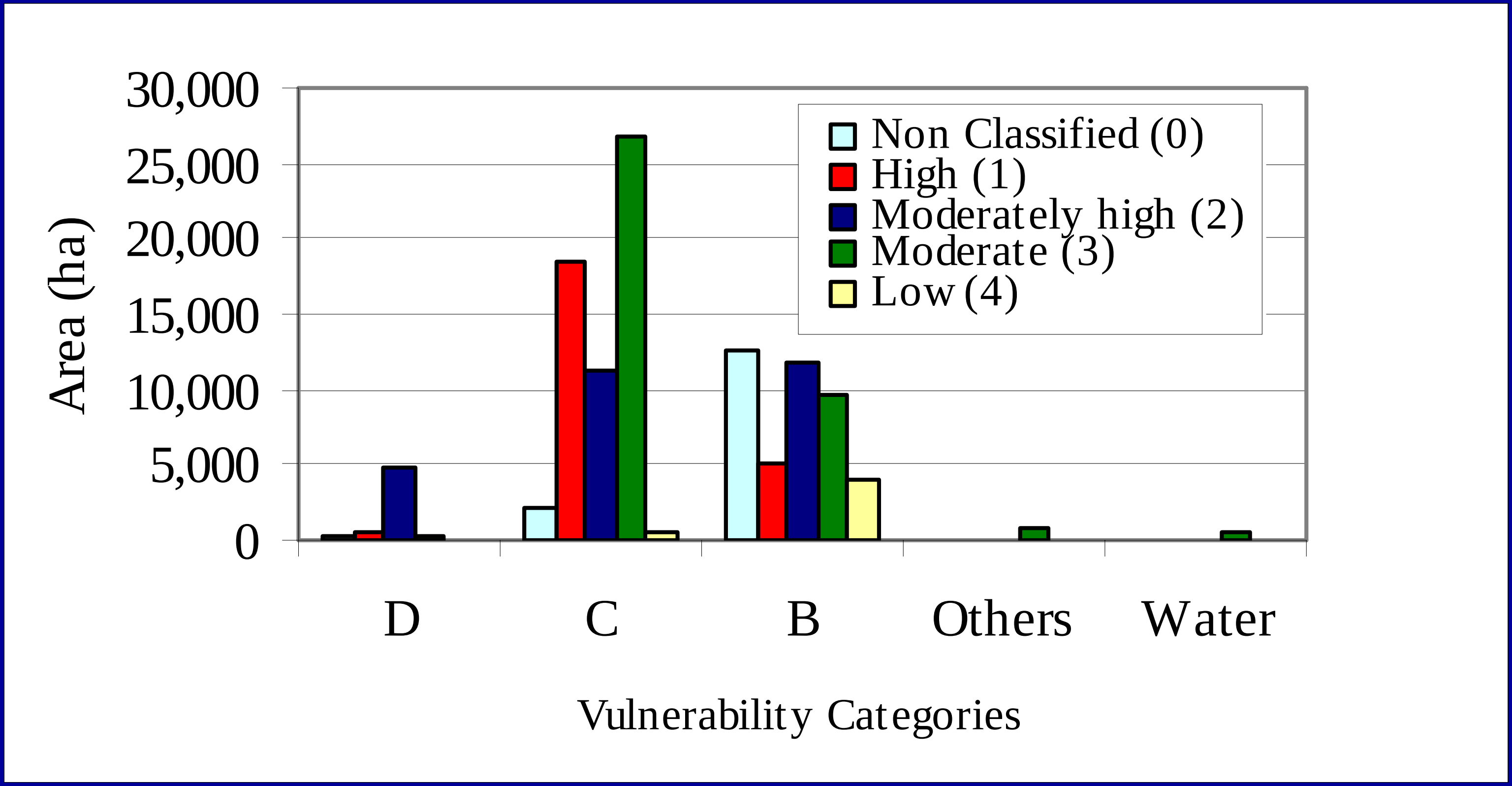
Slopes vs. Vulnerability Categories



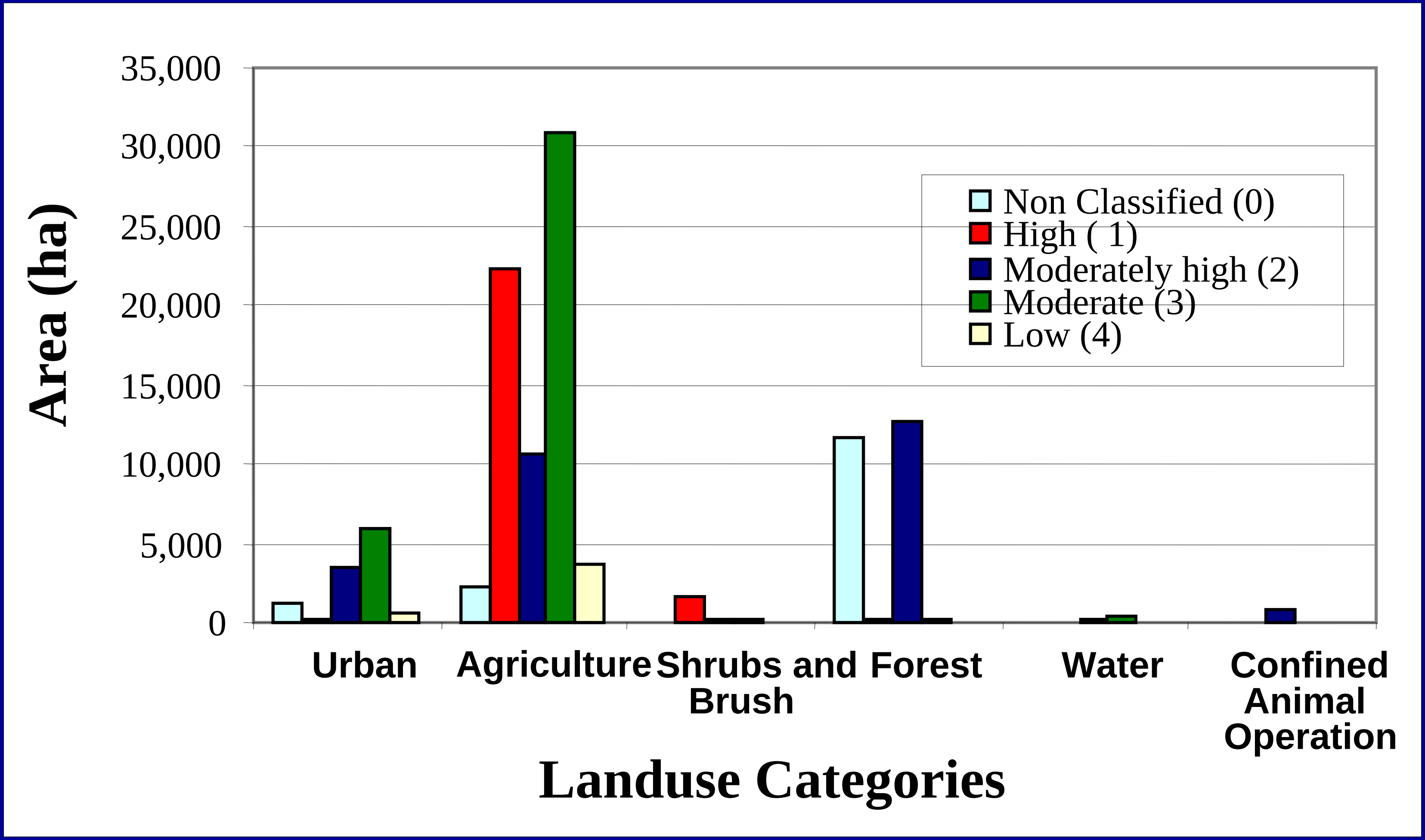
Geology vs. Vulnerability Categories



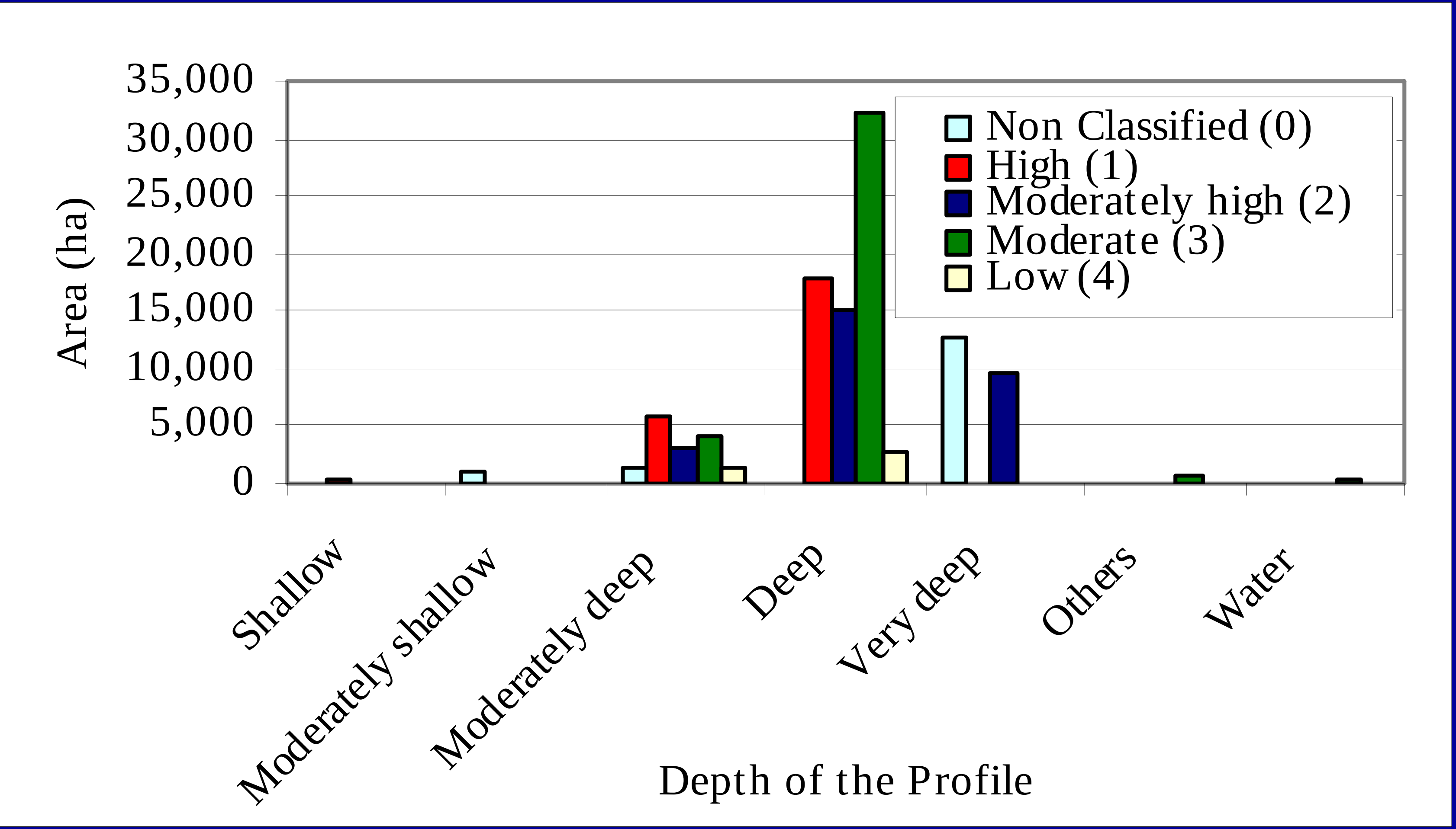
Soil Hydrologic Group vs. Vulnerability Categories



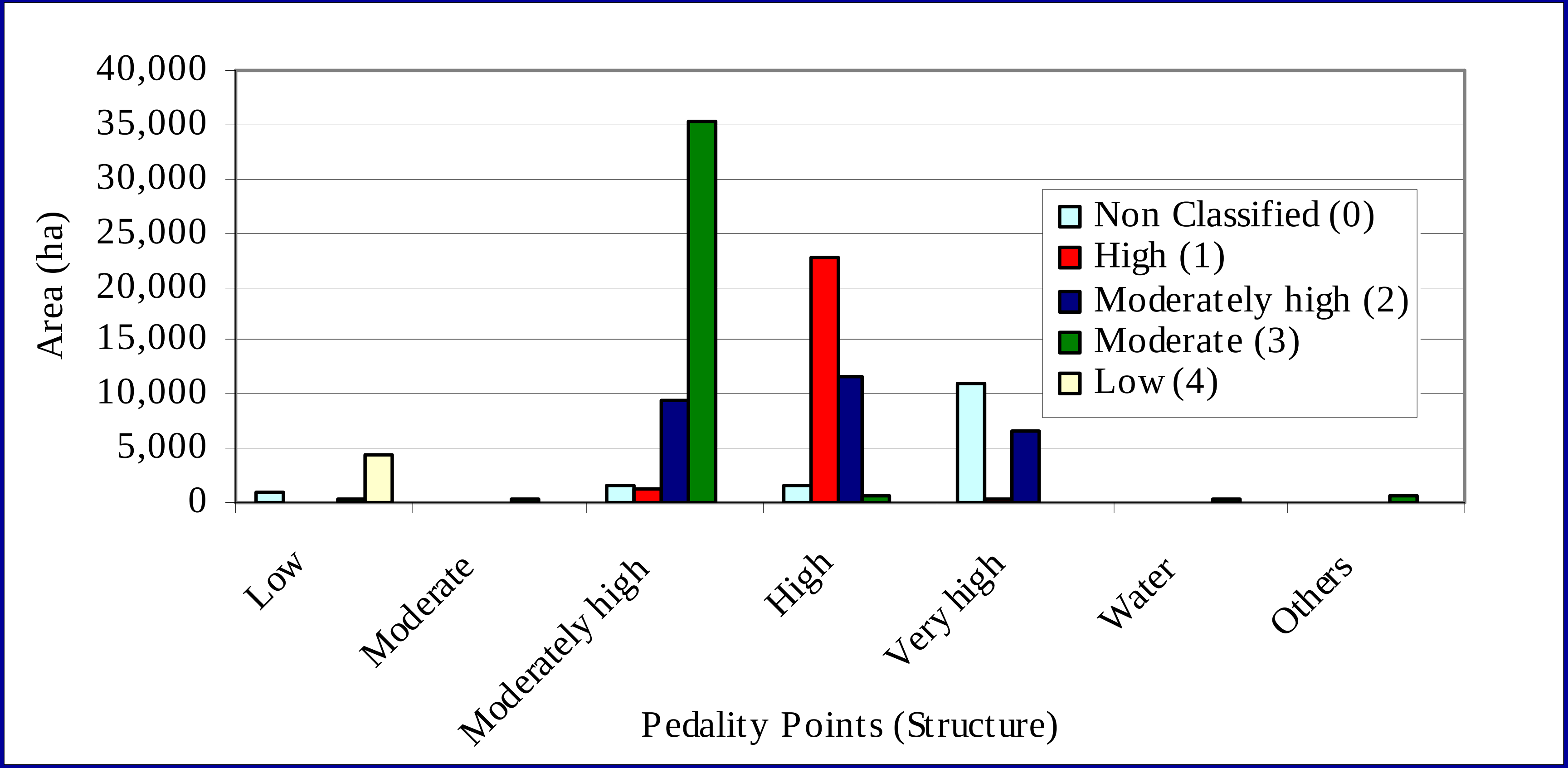
Landuse vs. Vulnerability Categories



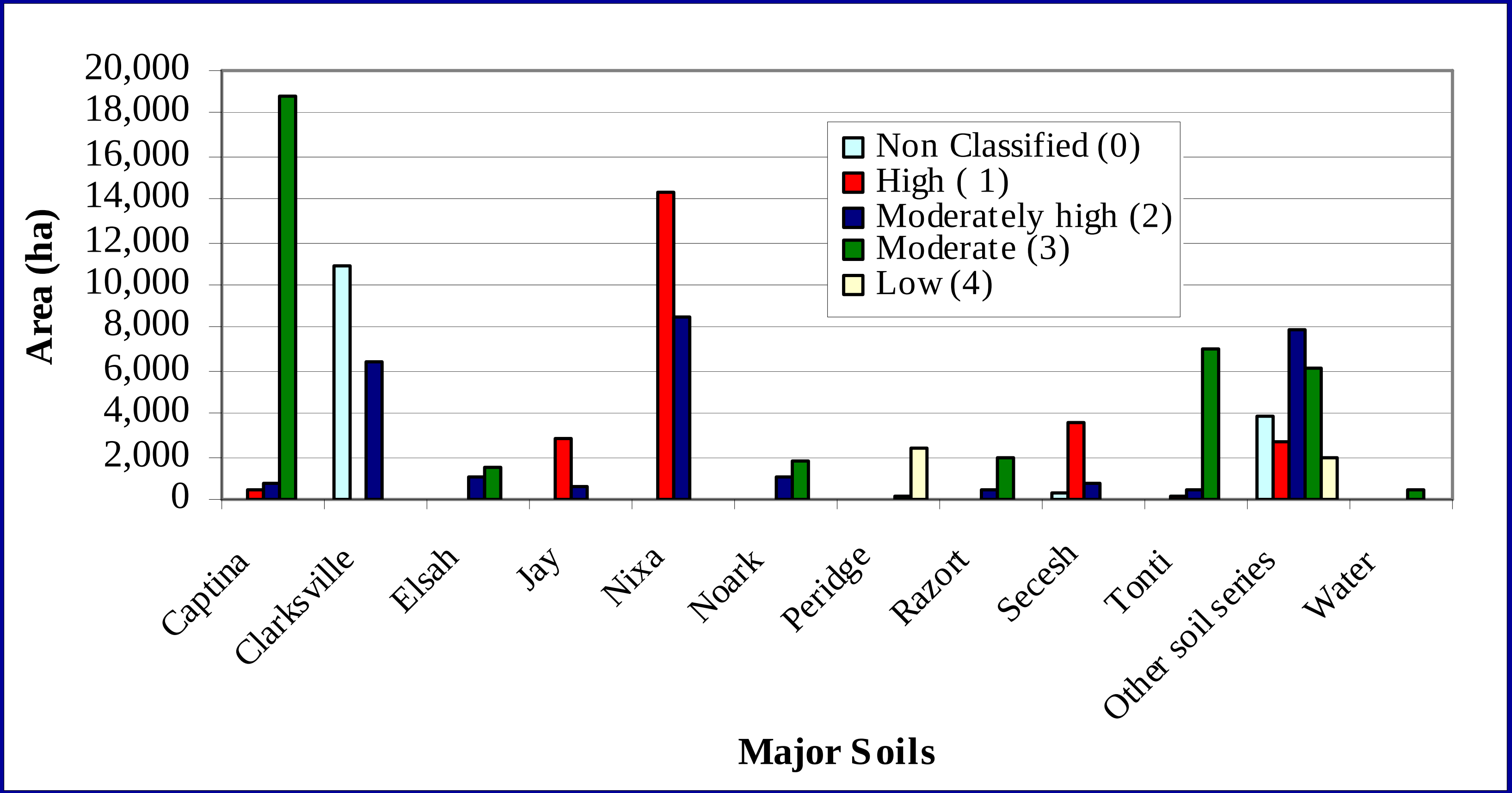
Soil Depth vs. Vulnerability Categories



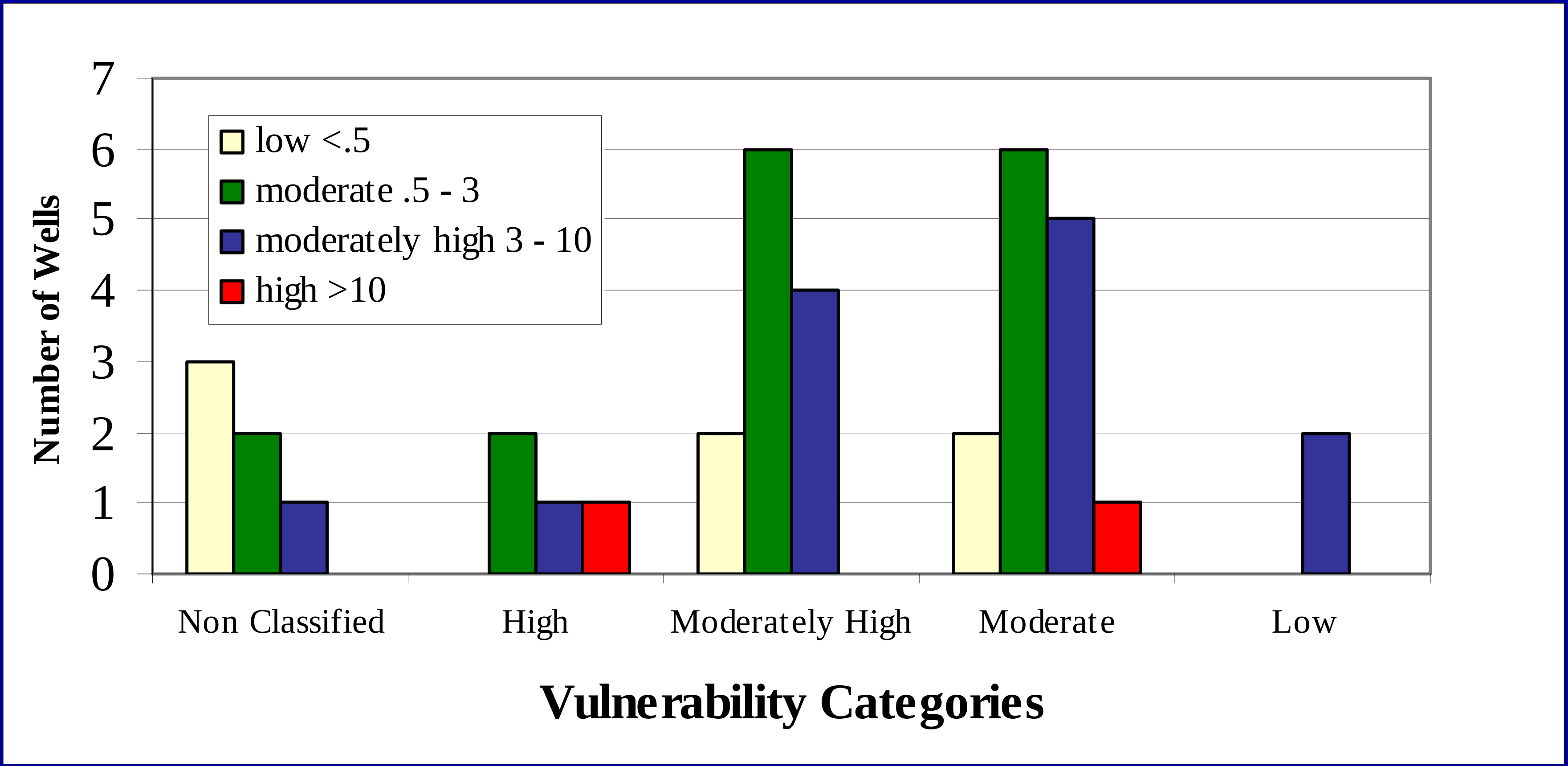
Soil Structure (Pedality Points) vs. Vulnerability Categories



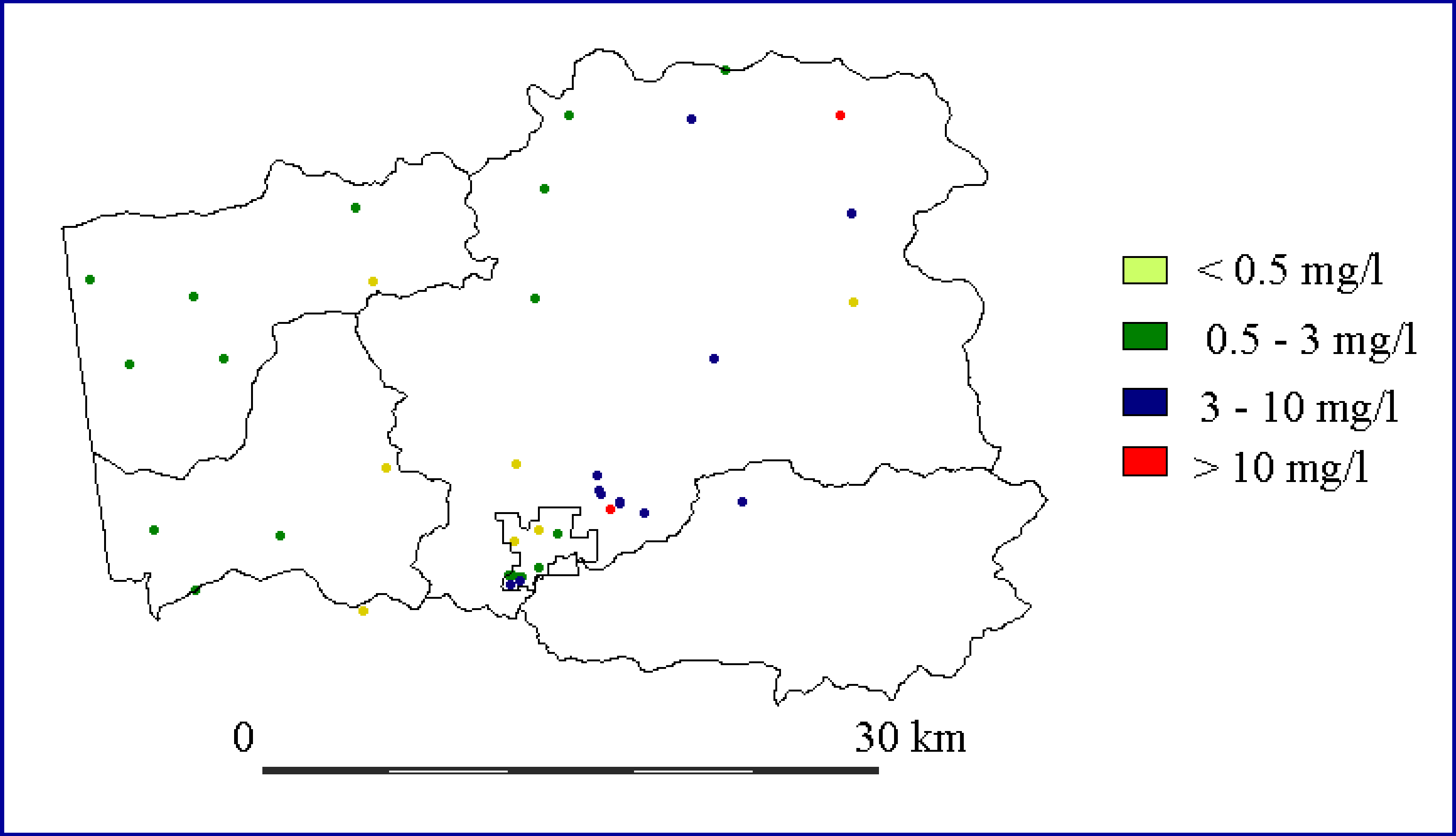
Soil Series vs. Vulnerability Categories



Nitrate-N Contamination Level vs. Vulnerability Categories



Spatial Distribution of Wells with Nitrate-N Contamination Level



Summary

- Soils with <u>high</u> water transmitting capacity, hydrologic group C, deep soil horizon coincided with highly vulnerable areas
- Soils with <u>moderately high</u> water transmitting capacity, hydrologic group C, deep soil horizon coincided with moderate vulnerability
- Soils with <u>low</u> water transmitting capacity, hydrologic group B, deep soil horizon coincided with low vulnerability category

Summary cont...

- Majority of the soils with high vulnerability coincides with agriculture
- Incorporation of landuse in the model need to be fine tuned i.e. potential use of agricultural inputs should be accounted for
- Use of the Neuro-fuzzy techniques saved time required to develop the preliminary model
- Further modification and fine tuning needed

Questions?