

Nitrogen loading of shallow groundwater aquifers in varying soil and topographic settings of southwestern Indiana.

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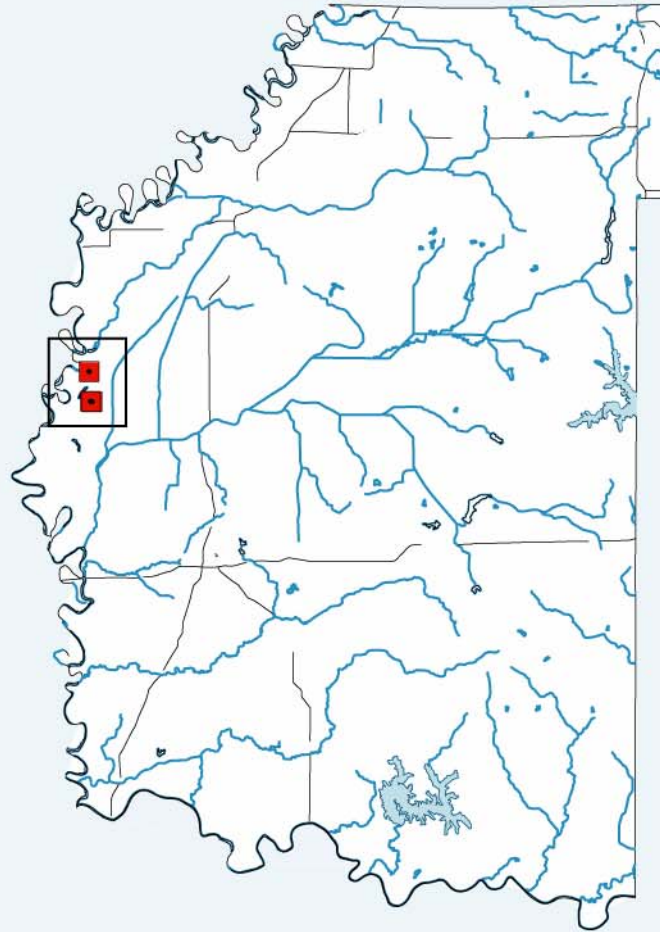
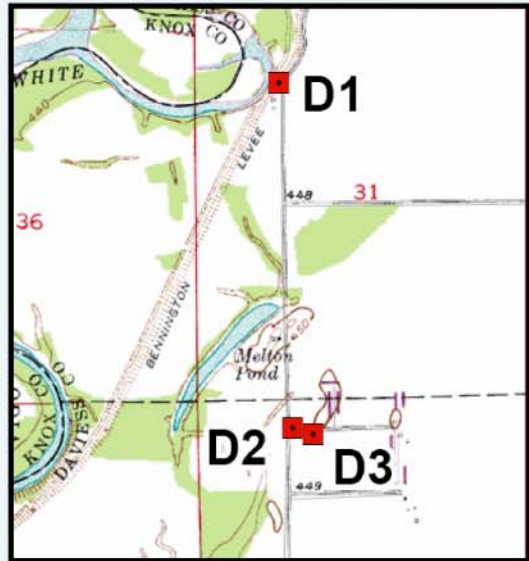
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Center for
Geospatial Data Analysis

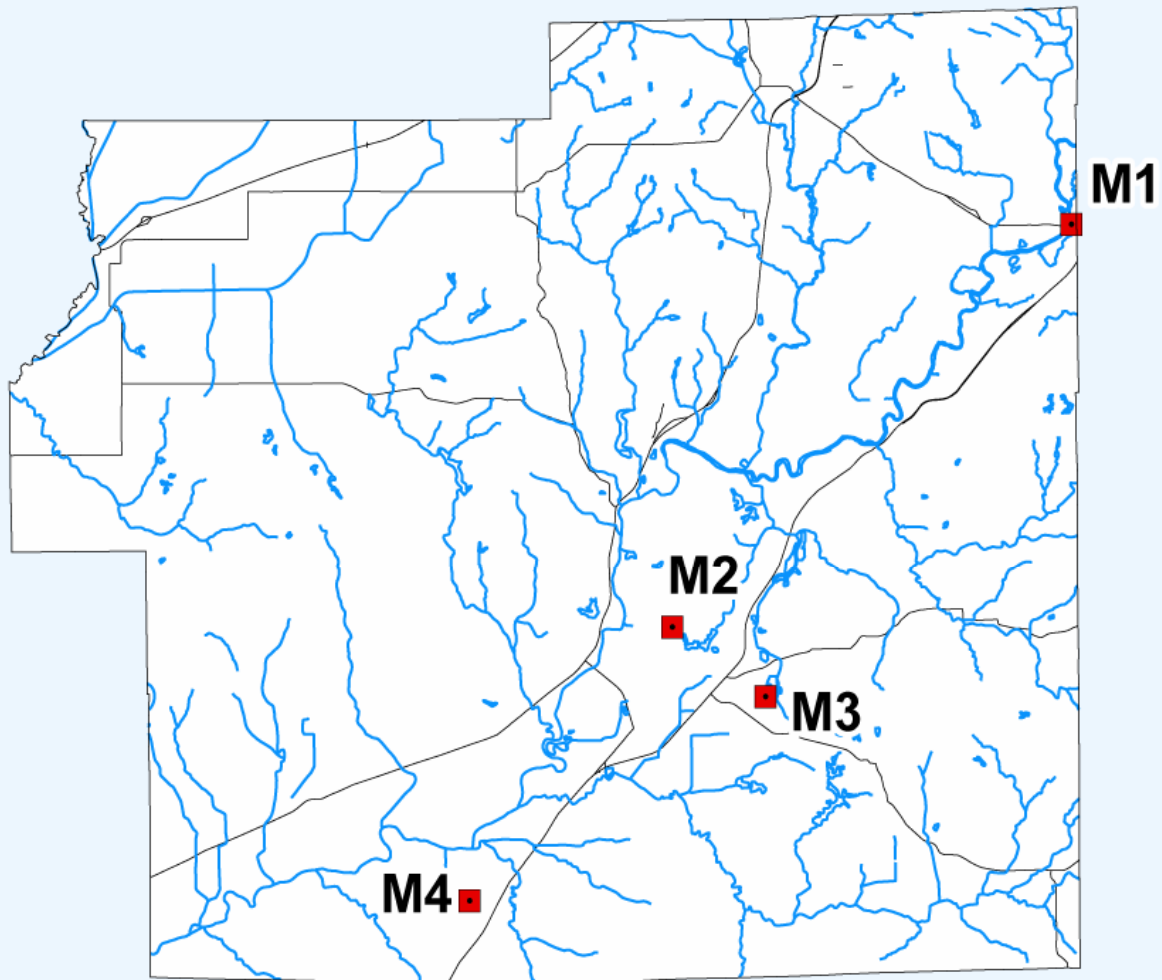




Daviess County, Indiana



- Study sites
- ~ Streams and water bodies

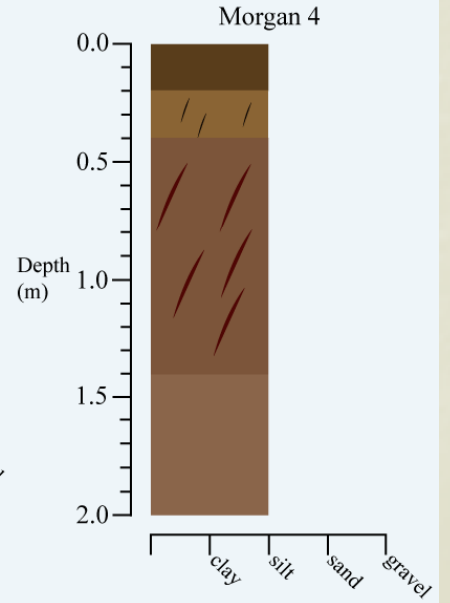
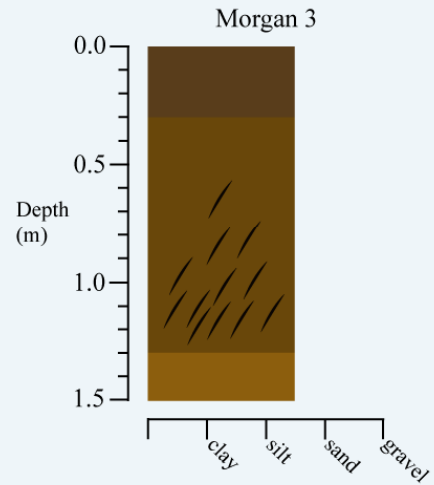
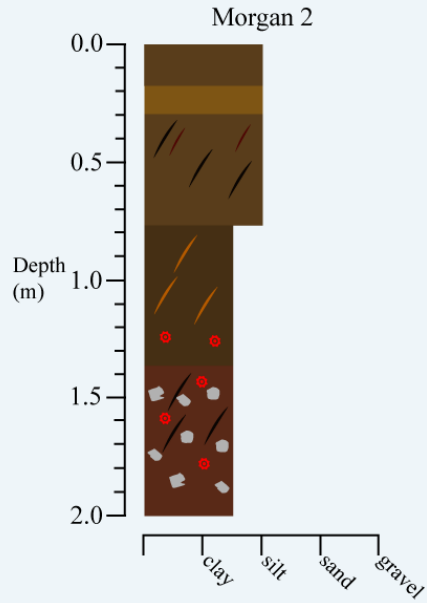
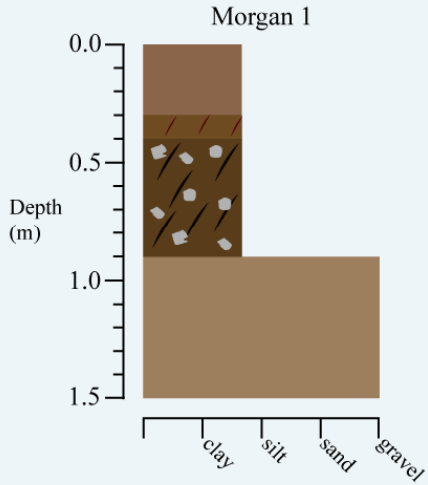
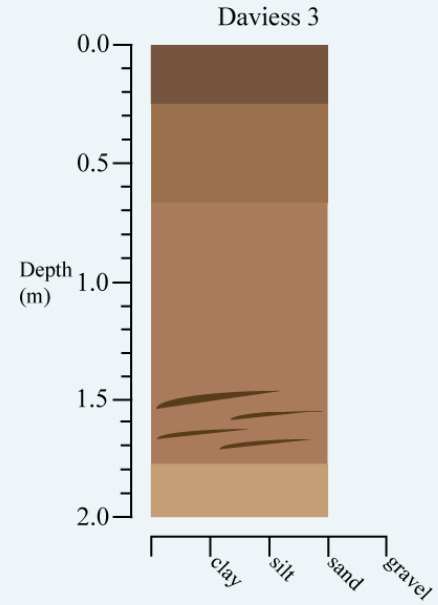
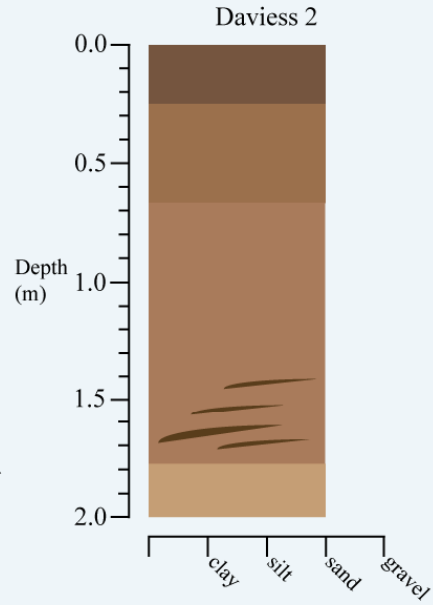
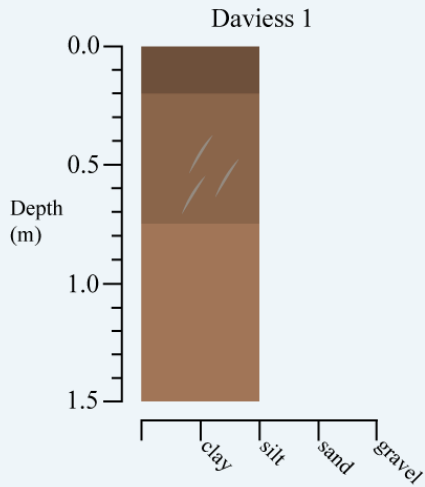


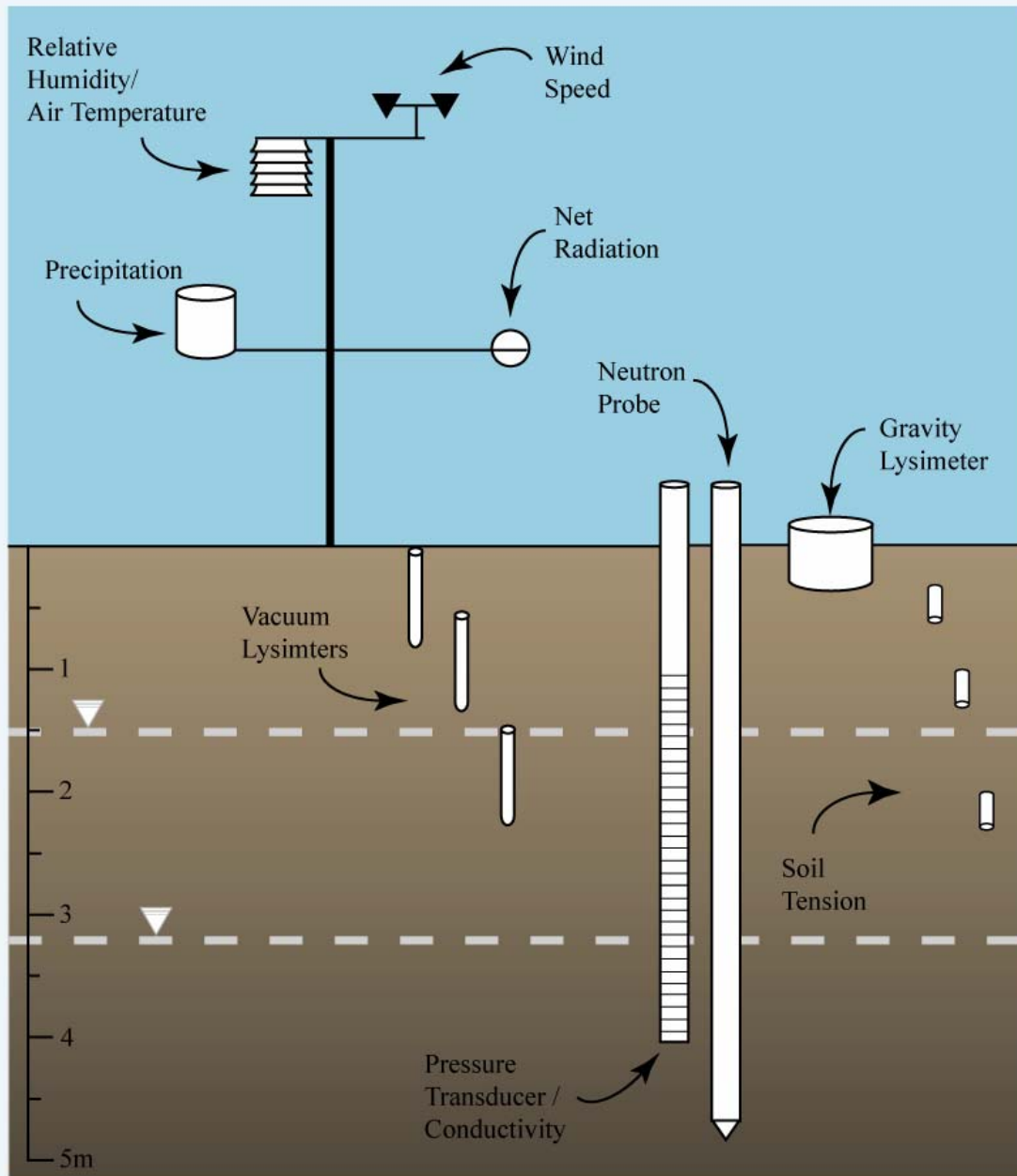
Morgan County, Indiana



■ Study sites

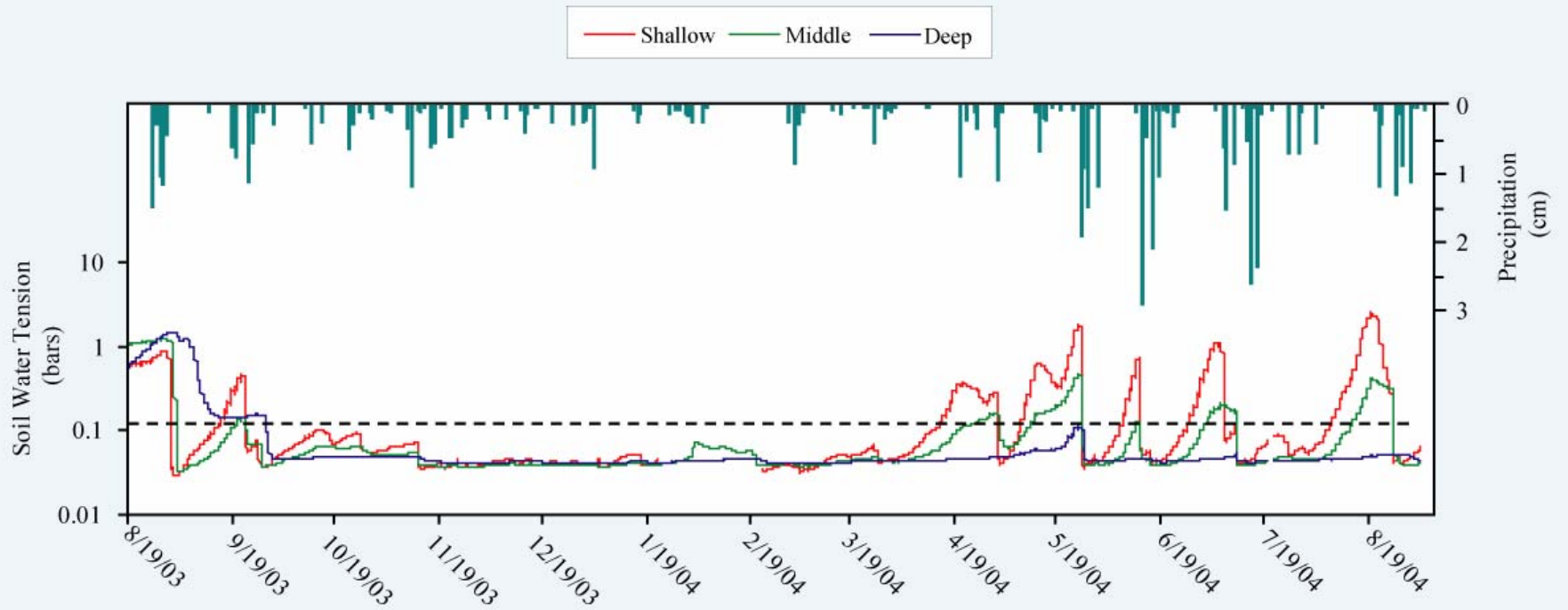
Streams and water bodies





Date	Shallow Tension (bars)	Middle Tension (bars)	Deep Tension (bars)	Specific Conductivity (mS/cm)	Net Radiation (W/m ²)	Wind Speed (m/s)	Relative Humidity (%)	Air Temperature (C°)	Rain (cm)	Water Table (m)
8/30/2003 0:00	0.040	0.041	0.037	0.344	-9.14	0.293	95.9	22.43	0	131.296
8/30/2003 1:00	0.040	0.041	0.037	0.346	-8.97	0.036	95.7	22.40	0	131.296
8/30/2003 2:00	0.040	0.041	0.037	0.350	-8.88	0.069	95.9	22.04	0	131.295
8/30/2003 3:00	0.040	0.041	0.037	0.355	-8.97	0.023	95.9	22.01	0	131.294
8/30/2003 4:00	0.040	0.041	0.037	0.357	-9.80	0.025	96.0	22.01	0.08	131.294
8/30/2003 5:00	0.040	0.040	0.037	0.358	-11.01	0.029	96.3	21.99	0.20	131.293
8/30/2003 6:00	0.040	0.040	0.037	0.359	-10.30	0.139	96.4	21.93	0.15	131.293
8/30/2003 7:00	0.040	0.039	0.036	0.361	-6.46	0.543	96.6	21.72	0.28	131.292
8/30/2003 8:00	0.041	0.039	0.036	0.361	10.88	0.158	96.3	21.99	0.10	131.291
8/30/2003 9:00	0.041	0.039	0.037	0.361	30.14	1.335	95.0	22.43	0	131.290
8/30/2003 10:00	0.041	0.039	0.037	0.362	62.98	0.315	93.2	22.99	0	131.289
8/30/2003 11:00	0.041	0.039	0.037	0.366	137.70	0.984	88.7	23.81	0	131.289
8/30/2003 12:00	0.041	0.038	0.037	0.368	135.30	2.184	85.6	24.59	0	131.288
8/30/2003 13:00	0.041	0.039	0.037	0.368	199.80	2.690	84.2	24.88	0	131.288
8/30/2003 14:00	0.041	0.039	0.037	0.368	245.50	2.789	83.4	25.03	0	131.288
8/30/2003 15:00	0.041	0.039	0.037	0.368	396.30	3.203	80.7	26.16	0	131.287
8/30/2003 16:00	0.041	0.039	0.037	0.366	298.90	3.470	79.1	25.58	0	131.287
8/30/2003 17:00	0.041	0.038	0.037	0.366	176.00	3.270	81.8	24.98	0	131.286
8/30/2003 18:00	0.040	0.038	0.037	0.366	76.40	3.348	82.3	24.64	0	131.285
8/30/2003 19:00	0.040	0.038	0.037	0.365	34.44	2.818	83.4	24.44	0	131.285
8/30/2003 20:00	0.040	0.038	0.037	0.365	-25.09	1.250	87.7	23.76	0	131.284
8/30/2003 21:00	0.039	0.038	0.037	0.364	-18.87	0.024	90.6	23.38	0	131.283
8/30/2003 22:00	0.038	0.038	0.037	0.363	-18.16	0.574	88.4	23.23	0	131.282
8/30/2003 23:00	0.037	0.038	0.037	0.363	-15.93	0.932	86.6	22.85	0	131.281

Sample	Date	Temperature (°C)	pH	Specific Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	Cl ⁻ (mg/L)	NO ₃ ⁻ (mg/L)	PO ₄ ⁻³ (mg/L)	K ⁺ (mg/L)	NH ₃ (mg/L)
D1-GL	12/8/2003	7.7	7.4	0.342	12.0	5.3	2.6	0.6	2.00	<0.10
D1-L7	12/8/2003	12.3	7.0	0.718	9.3	7.6	3.0	<0.5	0.50	<0.10
D1-MW	12/8/2003	11.9	7.2	0.588	5.9	18	28	<0.5	0.50	<0.10
D2-GL	12/8/2003	6.1	7.4	0.329	11.8	4.1	18	5.1	4.40	2.38
D2-L1	12/8/2003	7.3	7.1	0.574	11.9	8.5	130	10	6.30	0.11
D2-L3	12/8/2003	8.6	7.1	0.669	11.0	3.7	121	16	7.80	<0.10
D2-L7	12/8/2003	10.3	7.2	0.468	10.5	0.9	14	12	27.3	<0.10
D2-MW	12/8/2003	12.1	7.4	0.414	9.3	0.5	51	<0.5	6.90	<0.10
D3-GL	12/8/2003	6.2	7.0	0.337	12.1	16	1.5	1.9	8.30	<0.10
D3-L1	12/8/2003	7.4	7.3	0.276	11.8	0.9	1.0	1.1	1.40	<0.10
D3-L3	12/8/2003	8.1	7.1	0.333	11.4	1.7	1.5	1.7	1.60	<0.10
D3-L7	12/8/2003	10.1	7.1	0.443	10.4	6.3	6.5	1.7	3.70	<0.10
D3-MW	12/8/2003	10.3	6.6	1.089	9.7	6.2	14	<0.5	6.40	<0.10



$$\text{Potential Evaporation} = \frac{\Delta' Q^* + \gamma f(u) (e_a - e)}{\Delta' + \gamma}$$

Date	Net Radiation (Ly/min)	Wind Speed (m/s)	Relative Humidity (%)	Air Temperature (C°)	PE (cm)	Rain (cm)
9/25/2003	0.19	1.01	60.2	18.4	0.089	0.00
9/26/2003	0.04	1.25	86.5	15.3	0.029	2.87
9/27/2003	0.16	1.88	68.0	17.5	0.097	0.64
9/28/2003	0.08	1.51	79.0	12.0	0.046	0.15
9/29/2003	0.15	1.48	65.9	11.7	0.076	0.00

$$\Delta' = \frac{de}{dT}$$

Q^* = Net allwave radiation

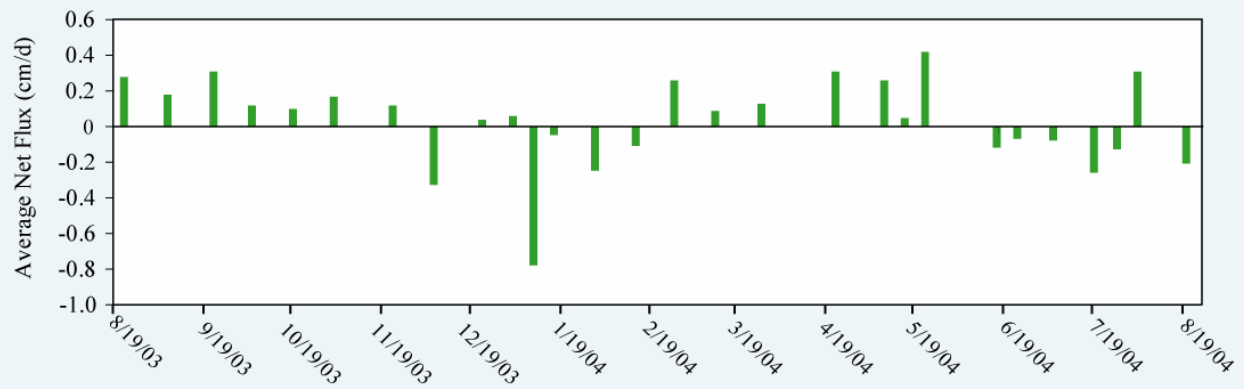
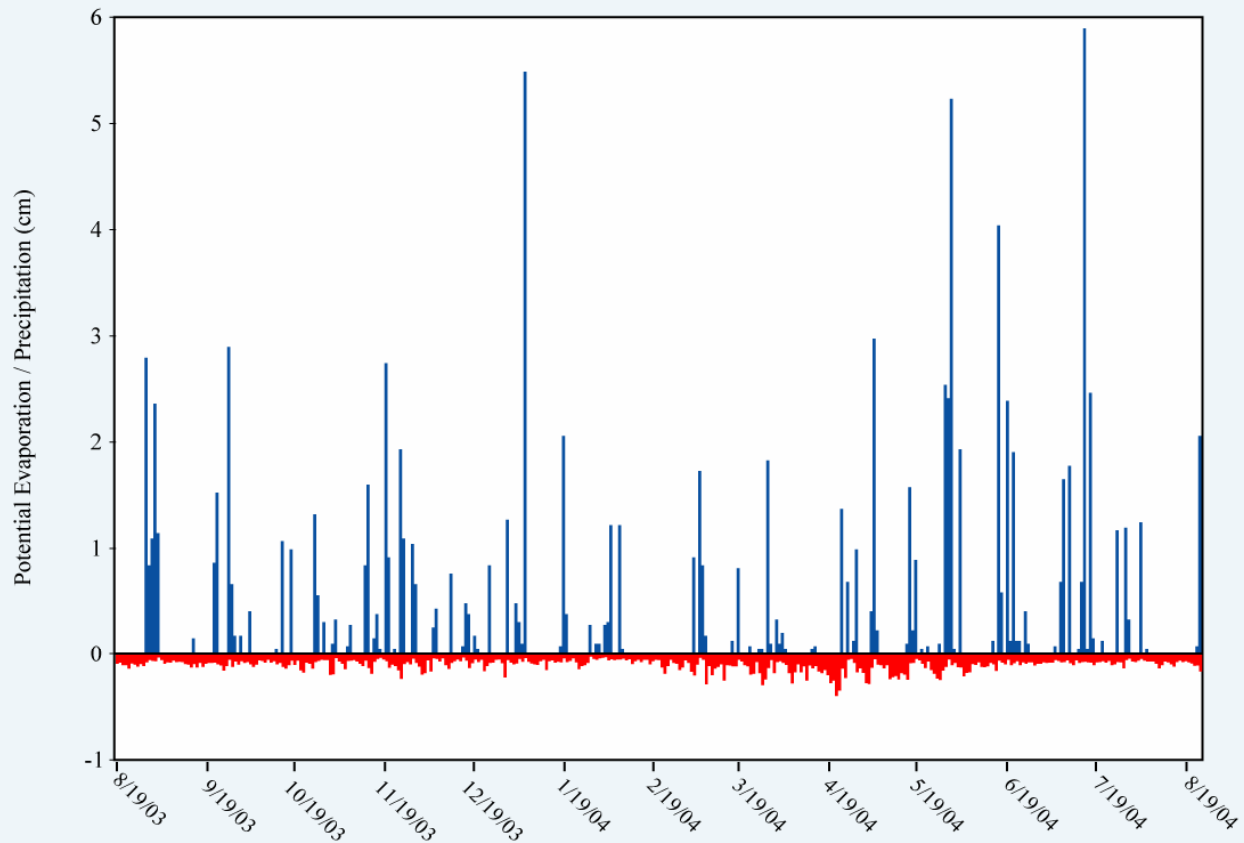
$$f(u) = 0.013 + 1.6 \times 10^{-4} u$$

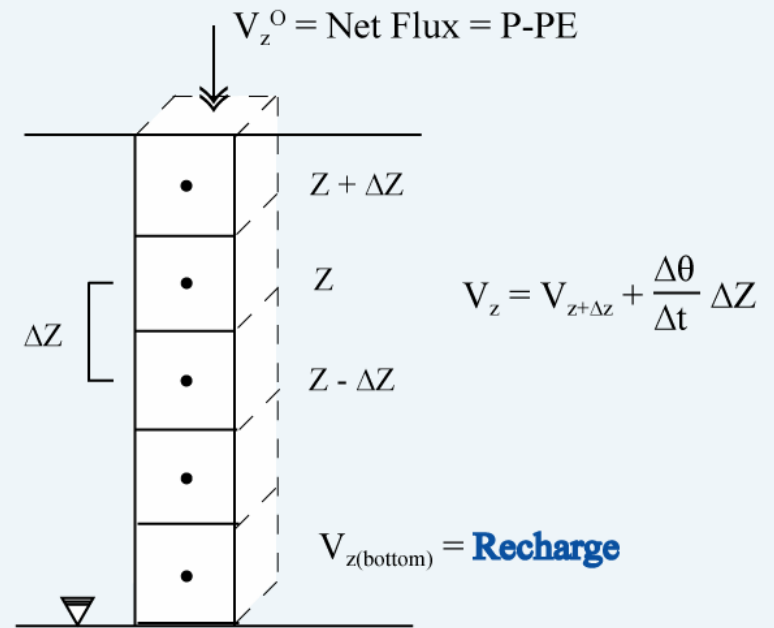
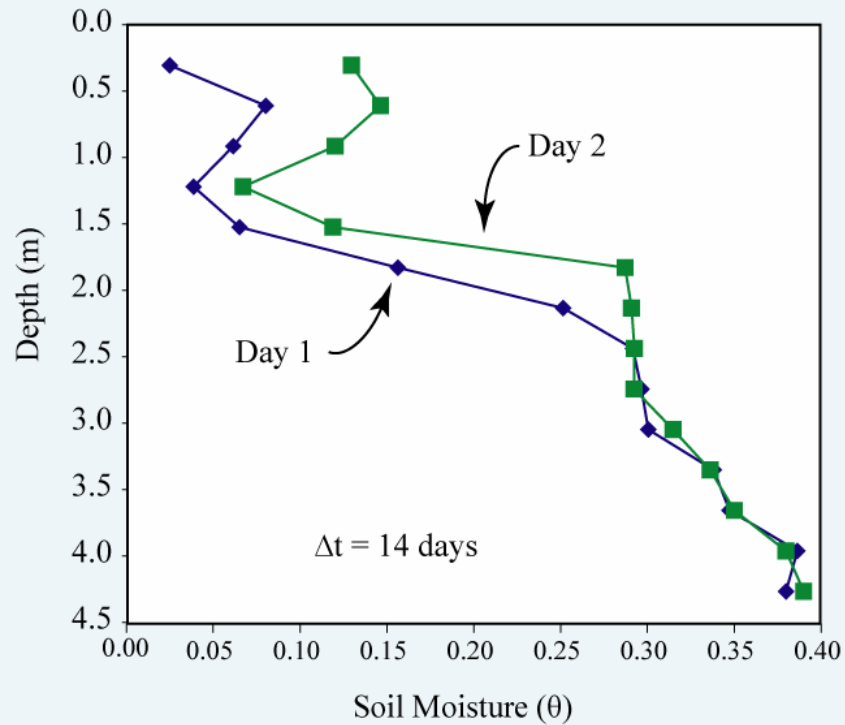
$$\gamma = 0.65 \text{ mbar/ } ^\circ\text{C}$$

e_a = Saturation vapor pressure

e = Actual vapor pressure

PE \approx f (Raditaion, Wind, Humidity, and Temperature)





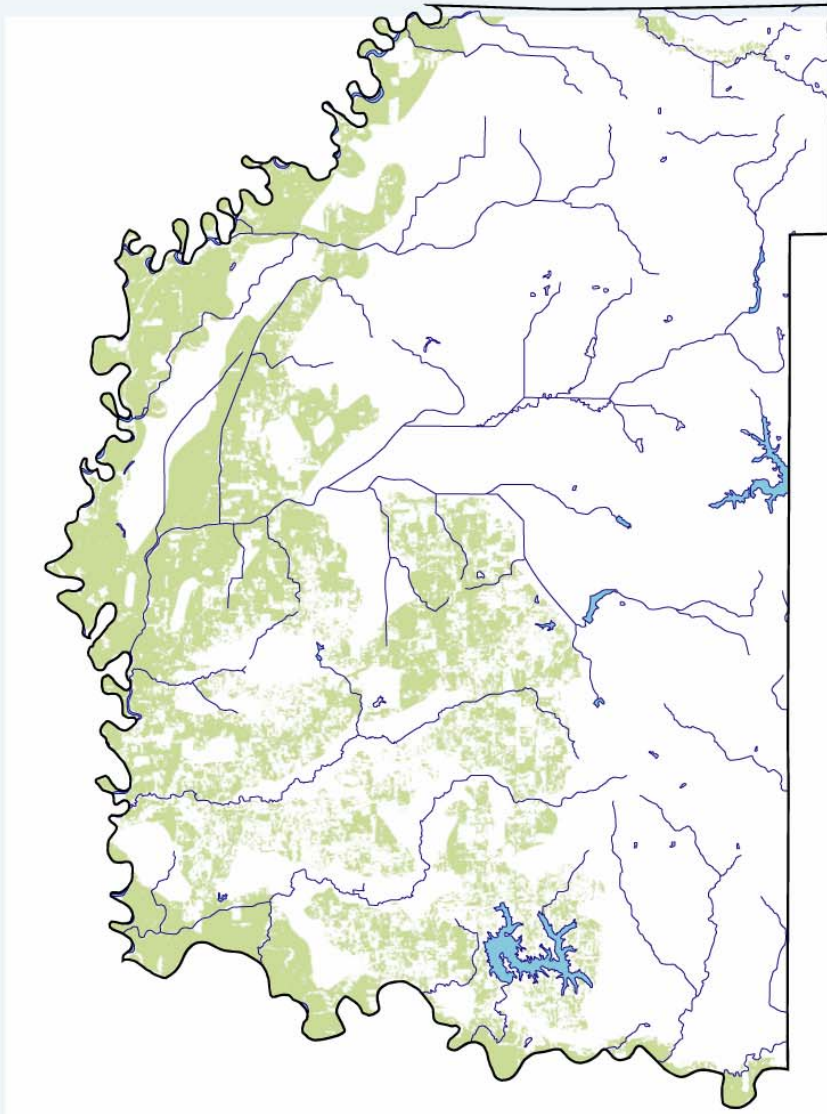
Location	Soil Type	Recharge (cm)	Average Nitrogen Concentration (mg/L)	Nitrogen Load (Kg/ha)
Daviess 1	Alluvium	35	6.6	24
Daviess 2	Sand Dune	24	56	135
Daviess 3	Sand Dune	29	17.5	21
Morgan 1	Terrace	5.2	14.38	7.4
Morgan 2	Loess/Till	4.8	8.06	3.8
Morgan 3	Sand Dune	8.3	1.55	1.3
Morgan 4	Siltstone	7.6	2.25	1.7

Loading =

Recharge x Average Concentration of Nitrogen in Unsaturated Zone

Limitations and Future Work

- Site specific
- Cost
- GIS – based maps



Daviess County, Indiana



 streams

 Area susceptible to nitrate transport

Criteria:

Land use = row crops

Static water table $\leq 7.5\text{m}$ (~25 ft)

Highly permeable surficial geology

- dune sand
- outwash
- alluvium

Acknowledgements

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- Tracy Branam and Ron Smith (IGS)
 - Chemical analyses
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