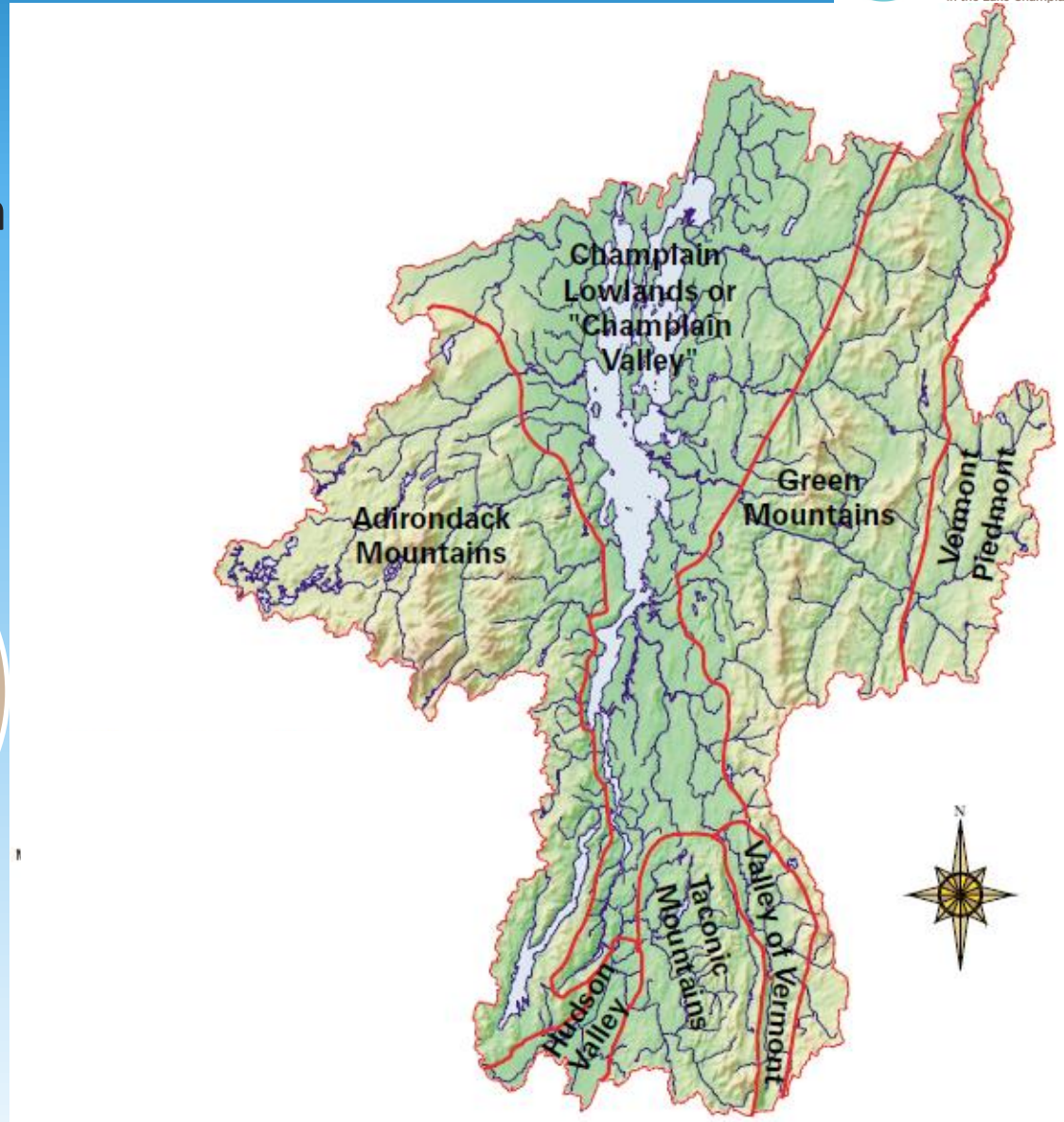
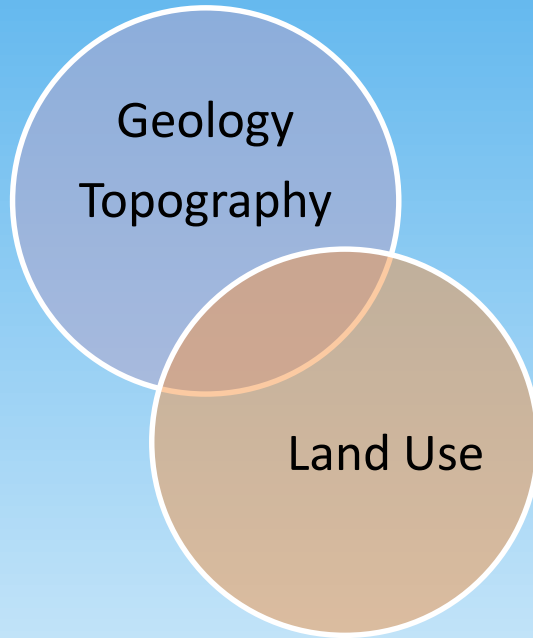


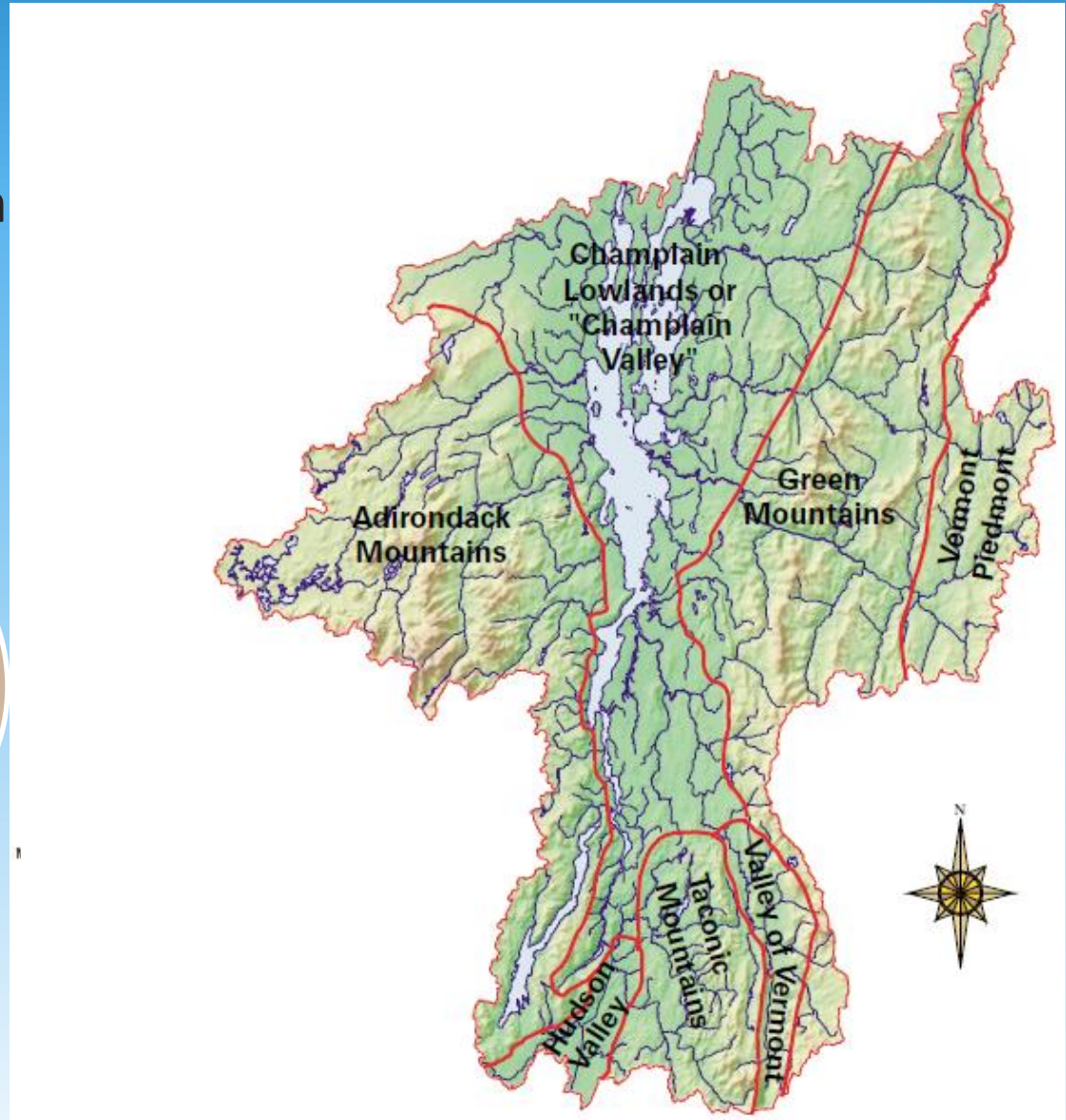
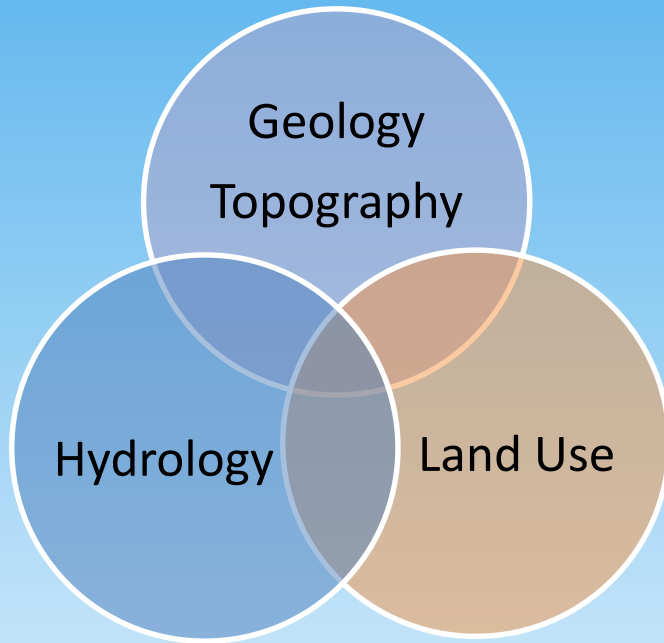
# Sediment & Nutrient Loading

Complex, nonlinear function  
of:



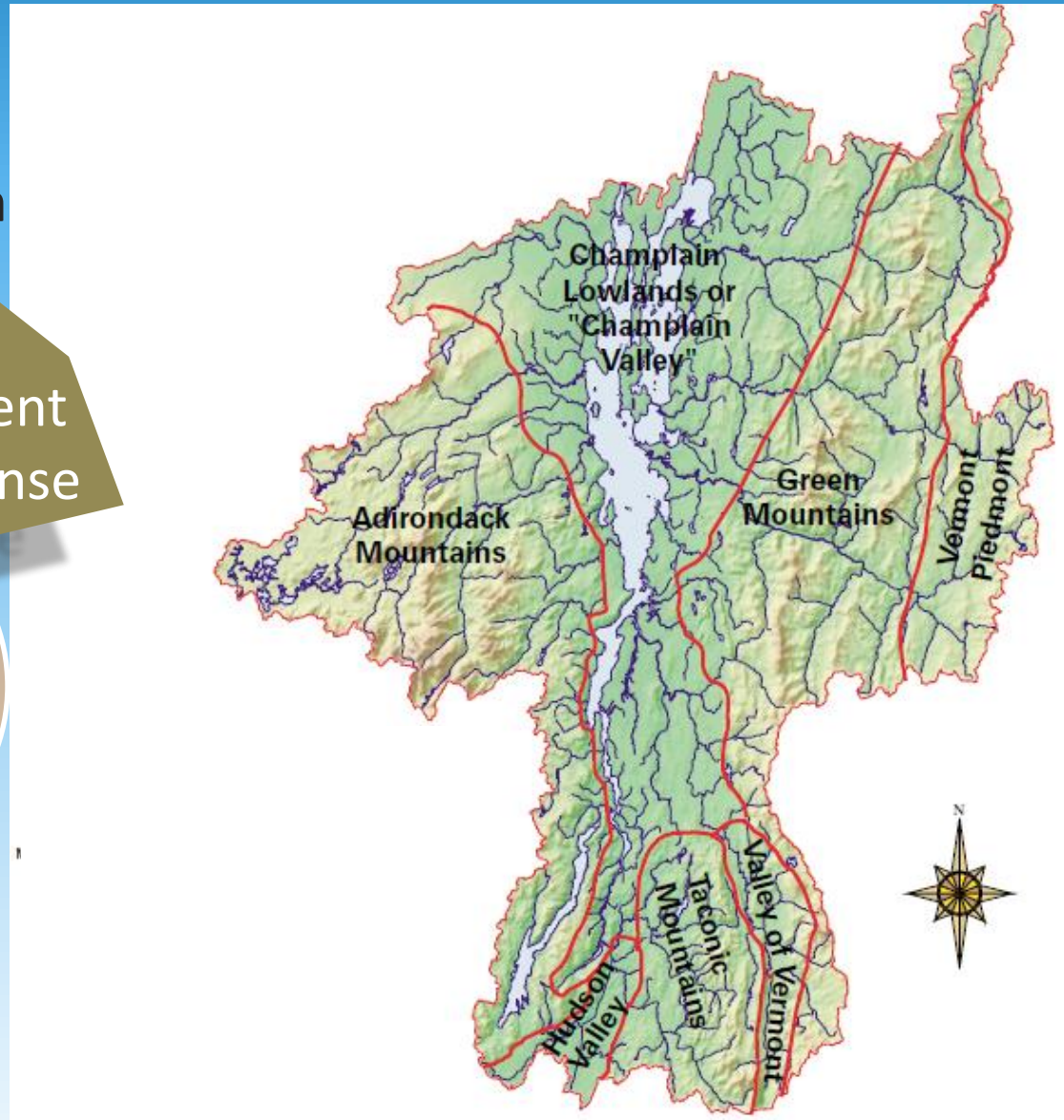
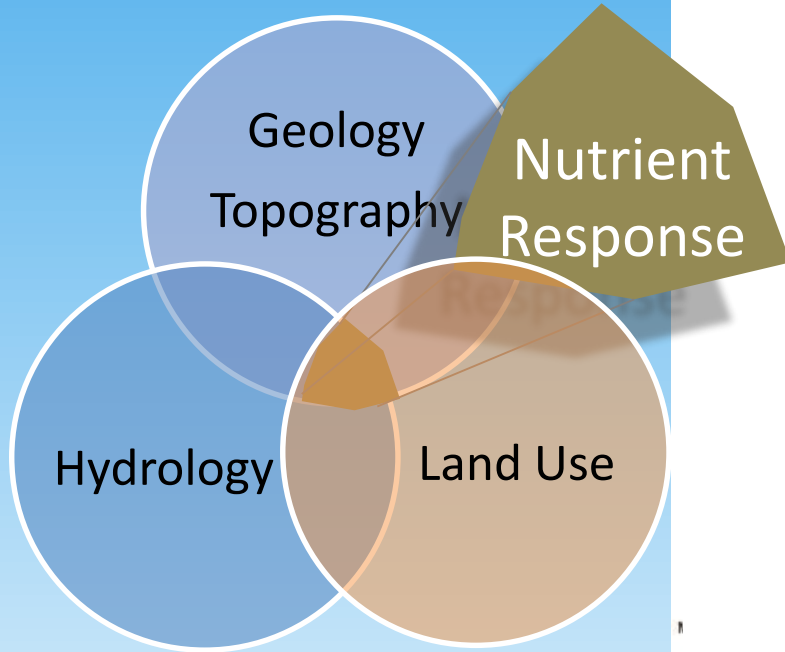
# Sediment & Nutrient Loading

Complex, nonlinear function  
of:



# Sediment & Nutrient Loading

Complex, nonlinear function  
of:

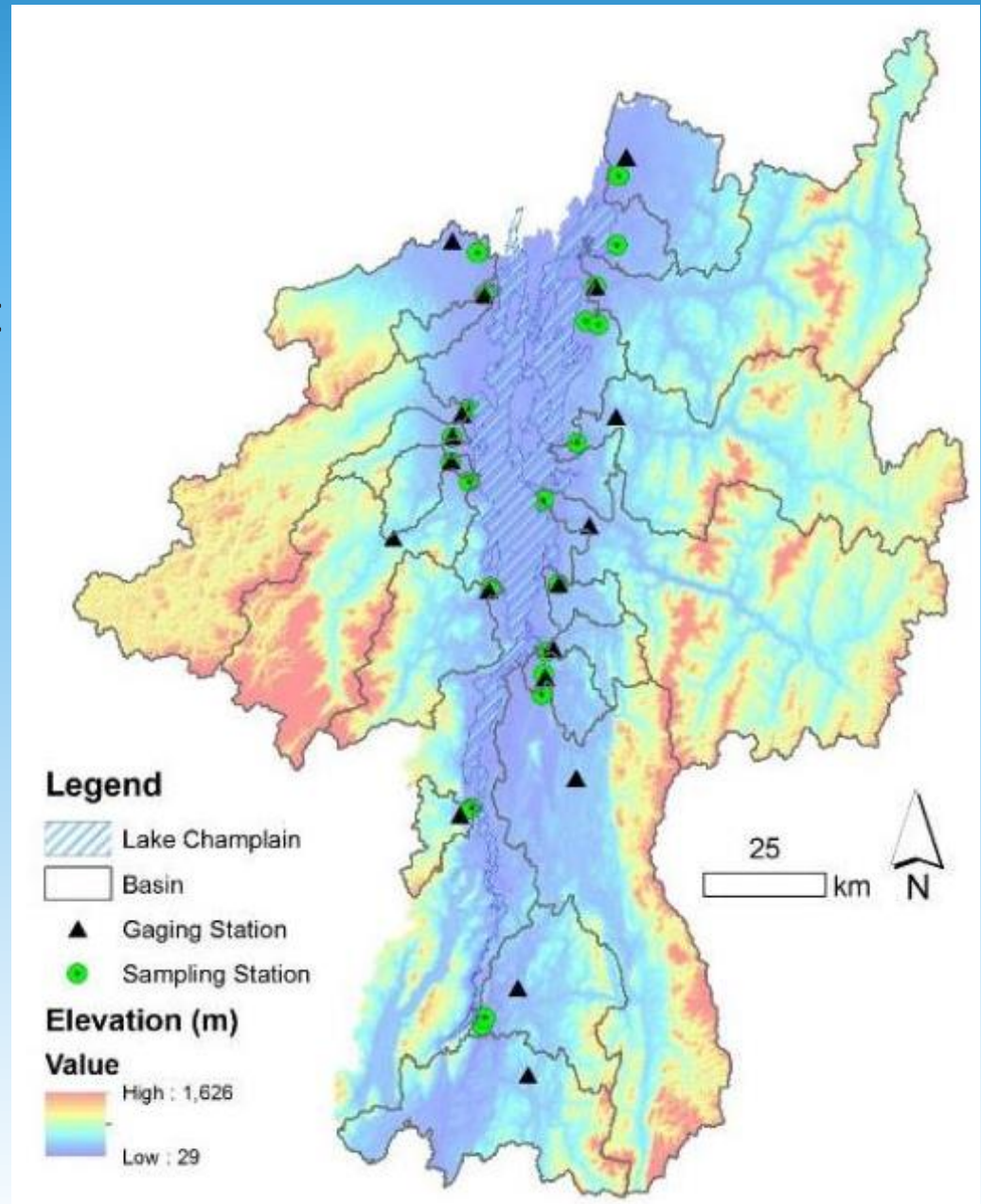
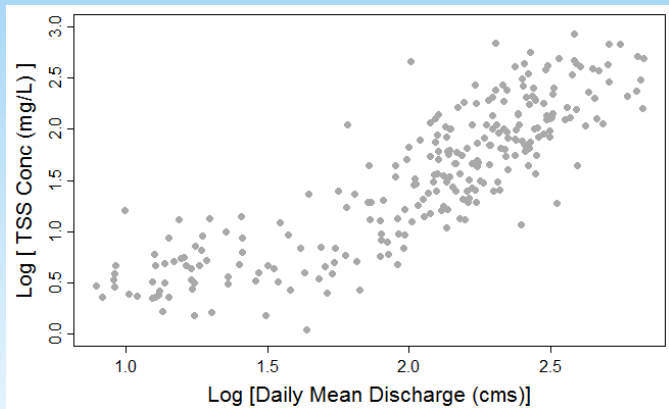




# Mining Extensive Data Sets

- 22 Tribs. (NYSDEC, VTDEC, Quebec)
- Monitored: 1990 – present
- 14 to 19 samples/yr.
- TSS, PP

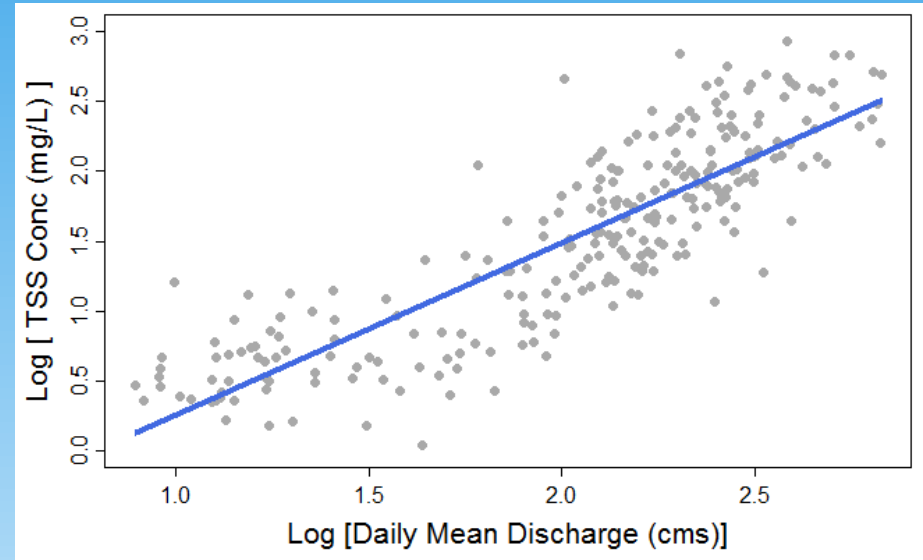
Winooski, TSS, 1992 -2015



# Interpretation of regression parameters

$$\log(C) = \log(b_0) + b_1 * \log(Q) + \epsilon$$

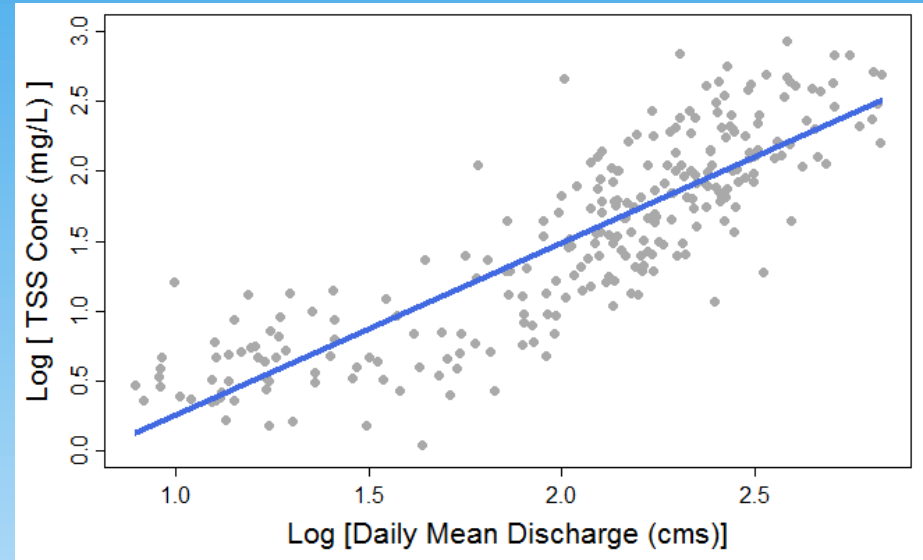
- $\log(b_0)$  – Baseline supply; background Conc. explained by variables other than changing discharge



# Interpretation of regression parameters

$$\log(C) = \log(b_0) + b_1 * \log(Q) + \epsilon$$

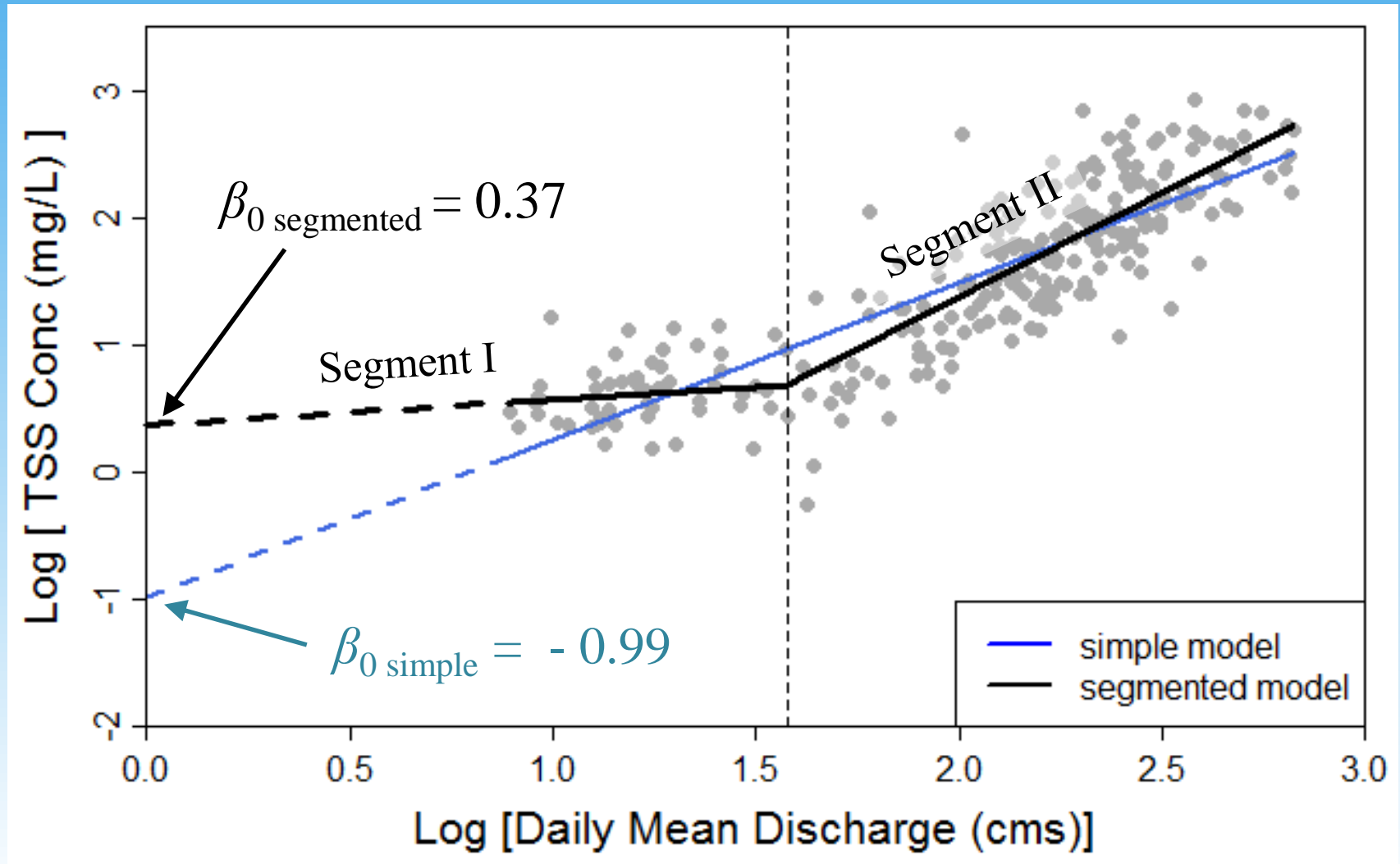
- $\log(b_0)$  – Baseline supply; background Conc. explained by variables other than changing discharge



- $b_1$  – indicator of the river's erosive power; Reflects rate at which the energy of flowing water is transferred to the physical surroundings to entrain and transport sediment and accomplish geomorphic change.

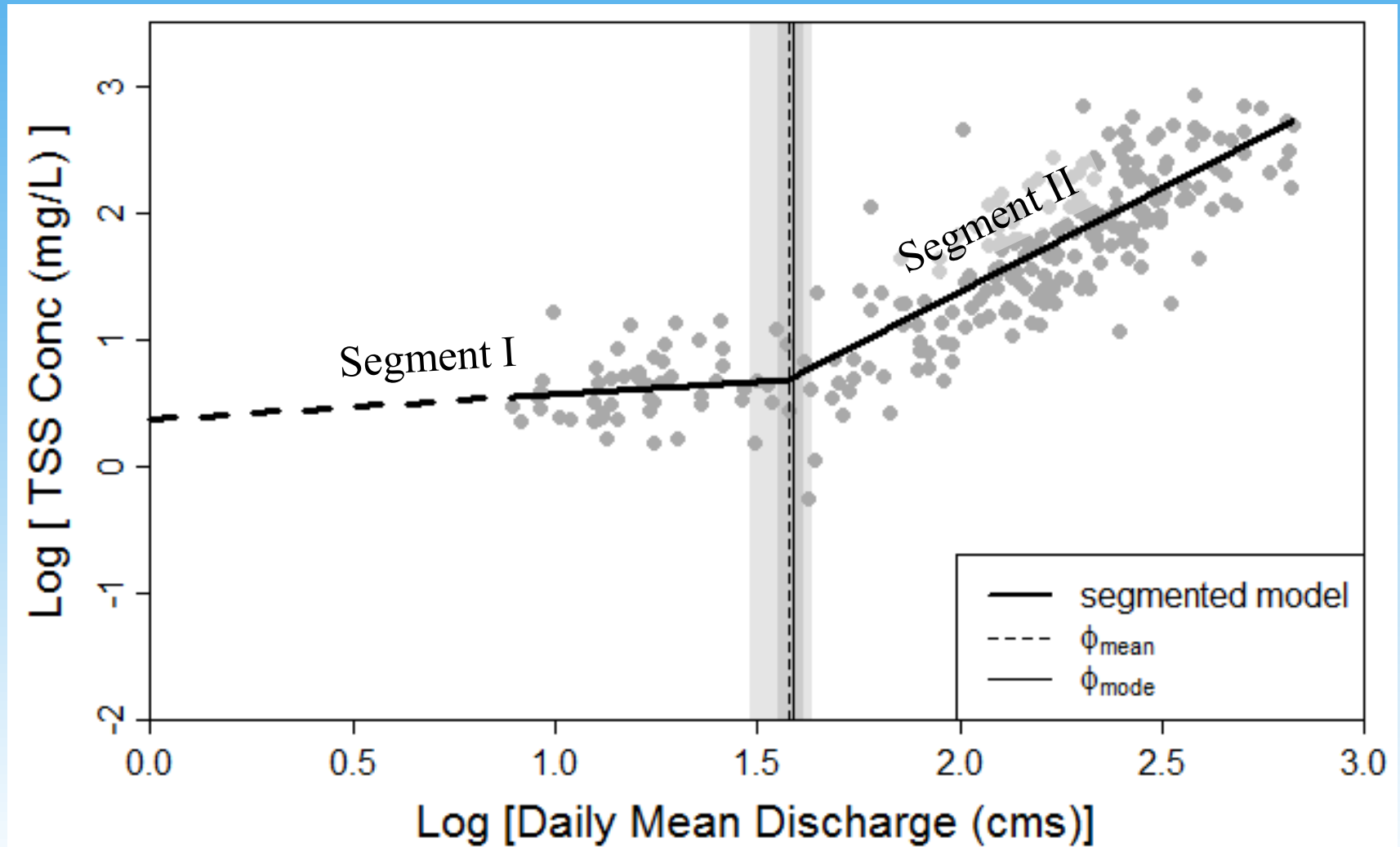
# Interpretation of regression parameters

## - Segmented Regression



# Threshold Models

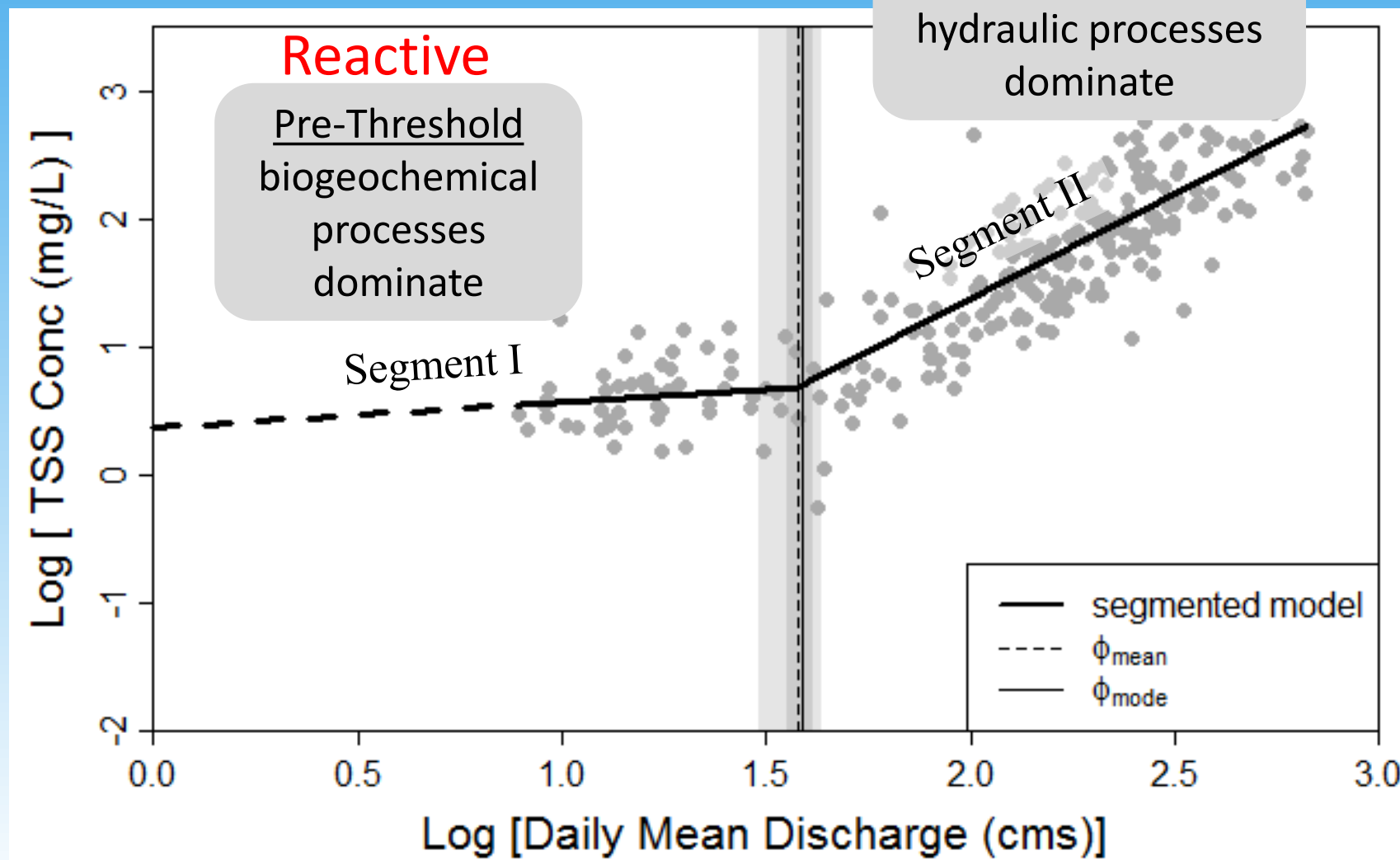
- Bayesian Linear Methods





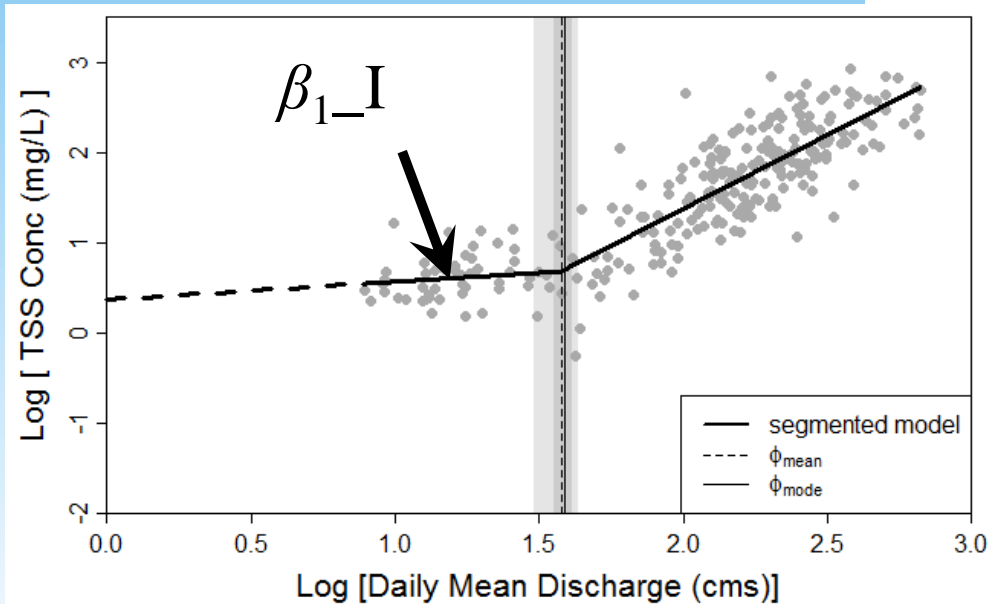
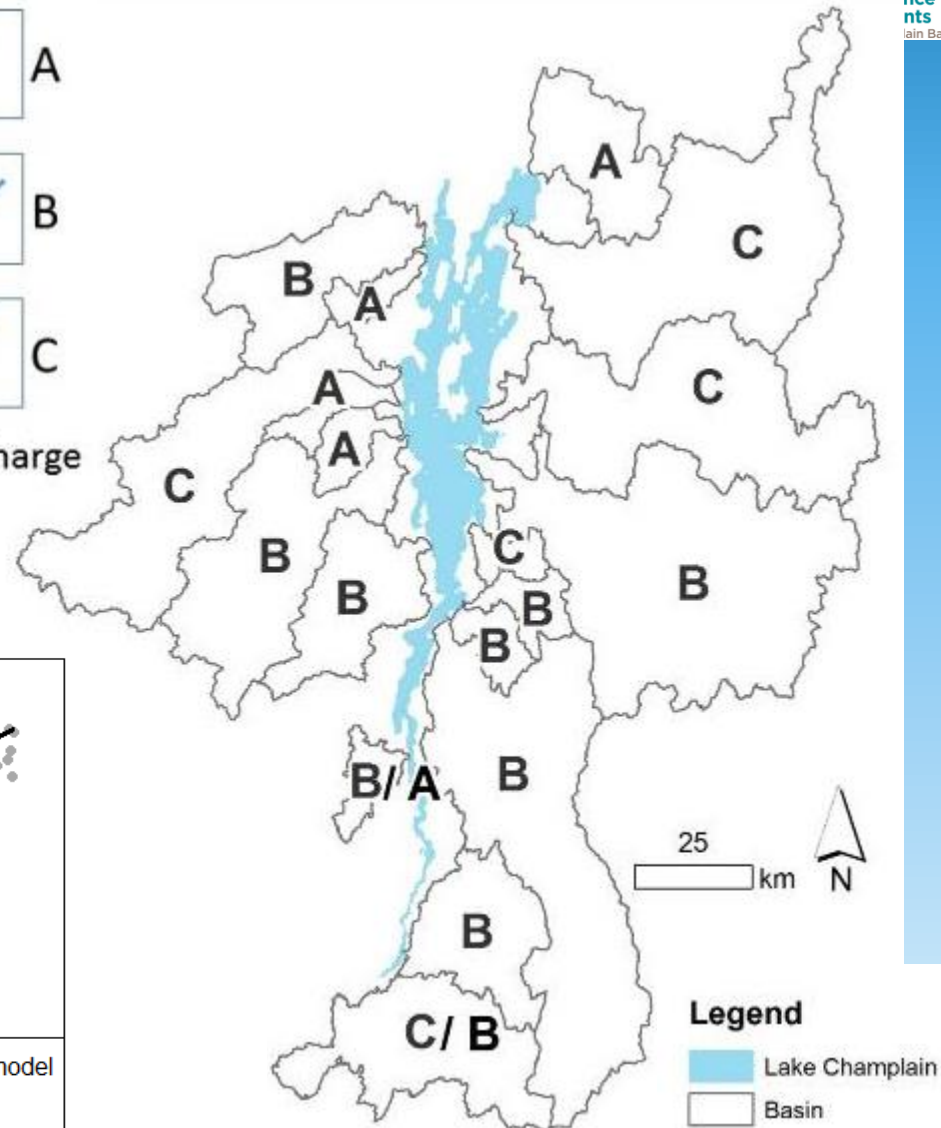
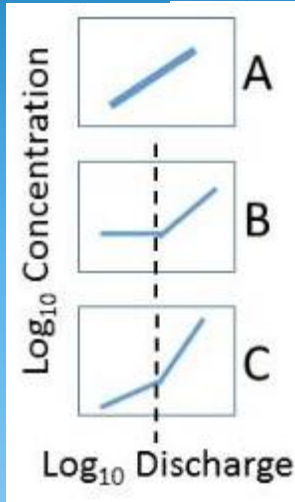
# Threshold Models

- Bayesian Linear Methods



# Threshold Models

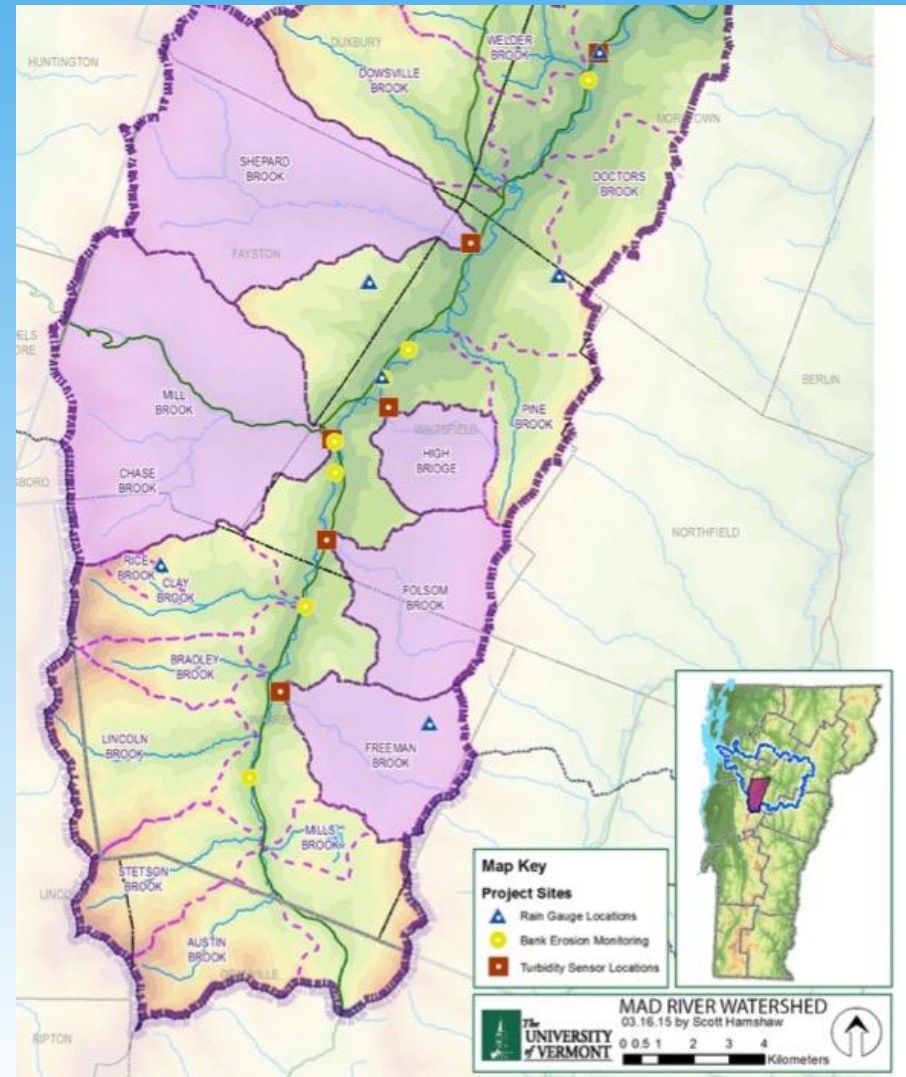
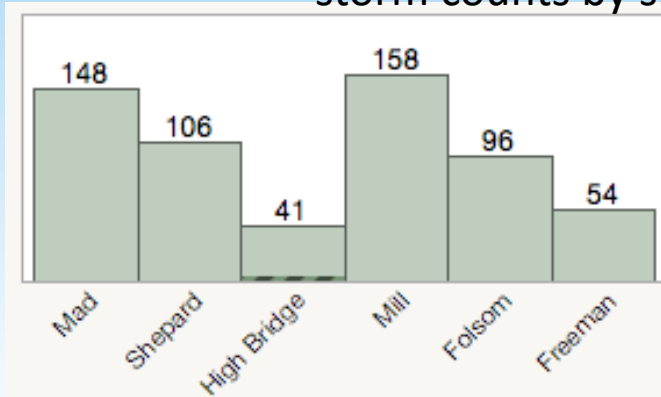
TSS  $\phi$  as a fraction of Q2:  
 Model B: 0.02 to 0.15  
 Model C: 0.07 to 0.63



# But wait...there's more (Data)

- Oct 2012 – Dec 2015
- 603 storms from 6 sites:
  - Mad River (MAD)
  - Shepard Brook (SHP)
  - High Bridge Brook (HBR)\*
  - Mill Brook (MIL)
  - Folsom Brook (FOL)
  - Freeman Brook (FRE)\*

storm counts by site



Source: Scott Hamshaw

\*2013 only and with approximated discharge

# Storm dashboard for each storm generated by Matlab script

Storm Date: 02-Jul-2014 00:45:00

Shepard Brook

Storm Number: 2.140702

Reference Rainfall Station: Fayston Weather (JFR)

Total Rainfall (mm): 13.46

Time Since Last Event (hr): 4

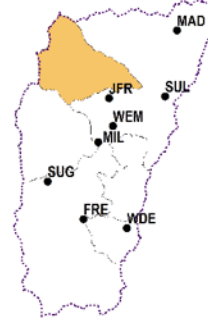
Rainfall-Runoff Ratio: 1.03 %

Turbidity Based Load (kg): 798

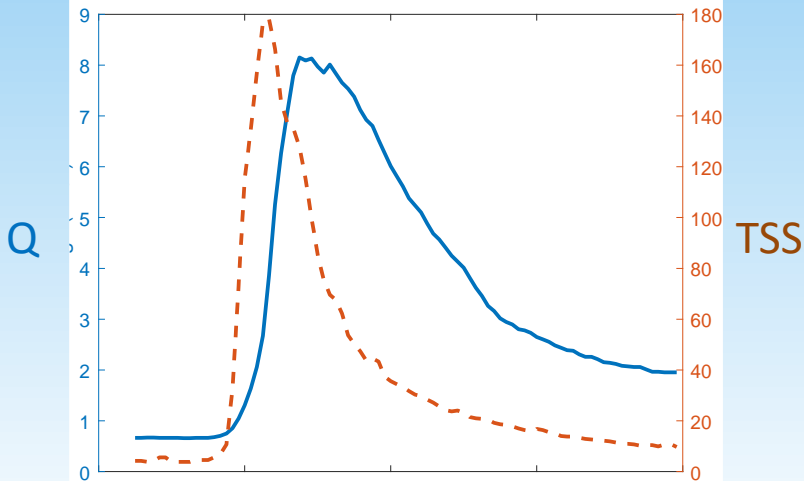
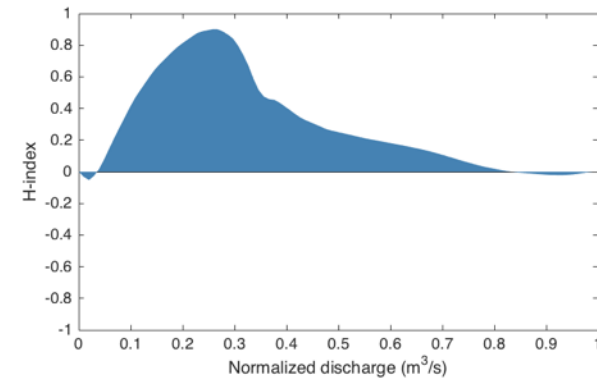
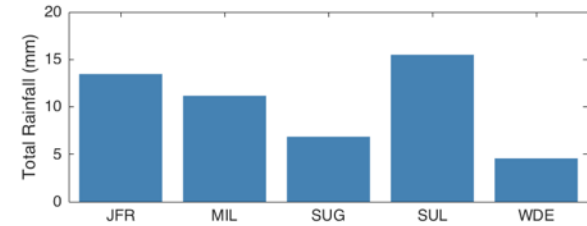
Flood Intensity: 0.059

Antecedent Soil Moisture (%): 29.61 %

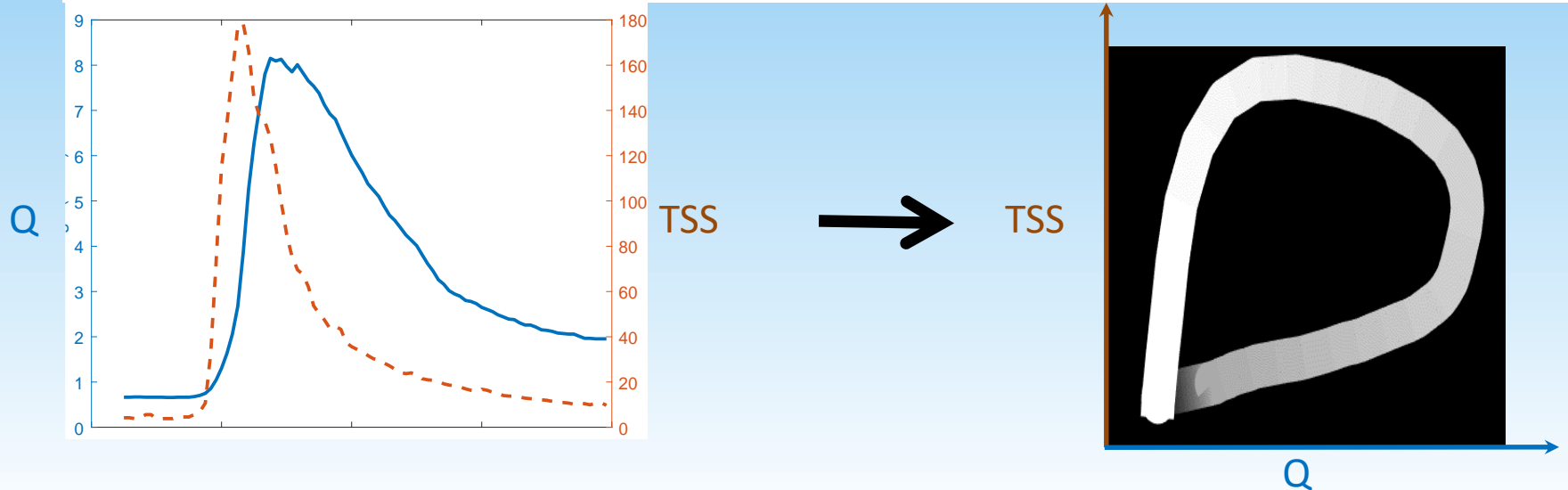
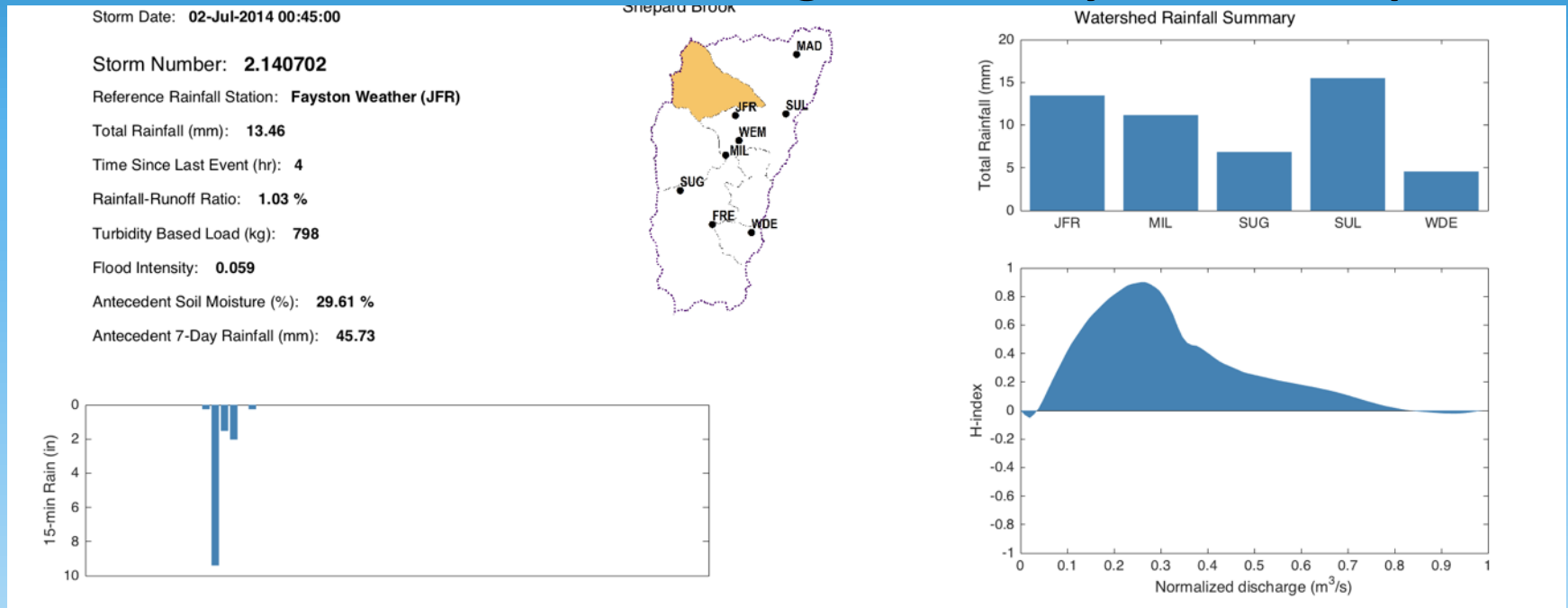
Antecedent 7-Day Rainfall (mm): 45.73



Watershed Rainfall Summary

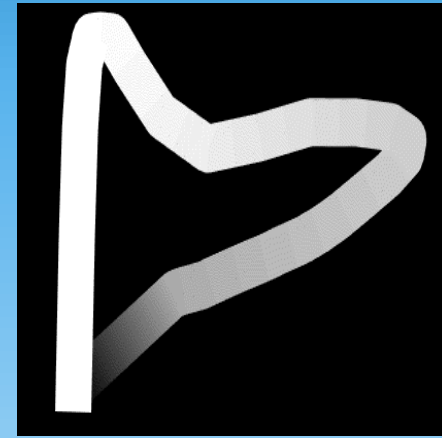
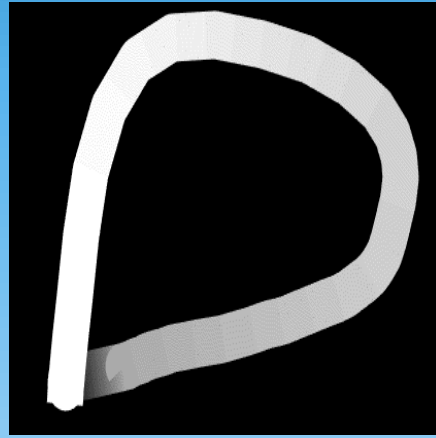
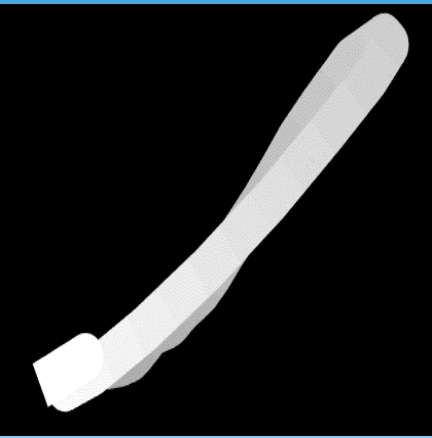


# Storm dashboard for each storm generated by Matlab script





# Identification of Hysteresis Classes

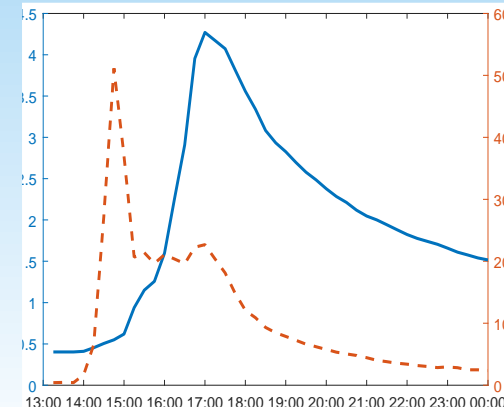
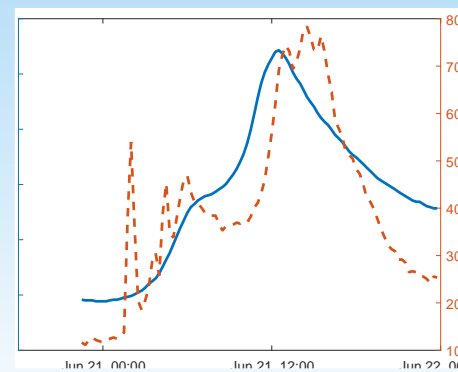
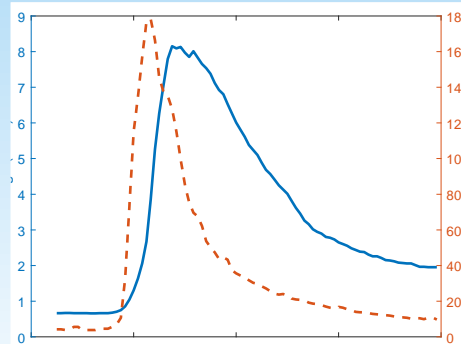
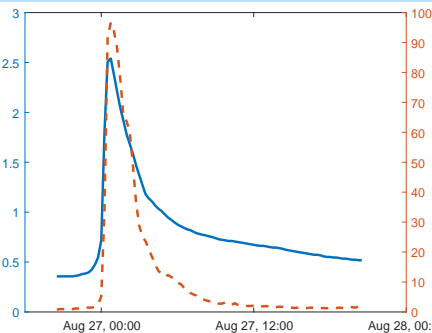


Class 1a  
Linear  
n = 13

- Class 2a
- higher antecedent moisture
  - most prevalent

Class 4  
Clockwise  
n = 42

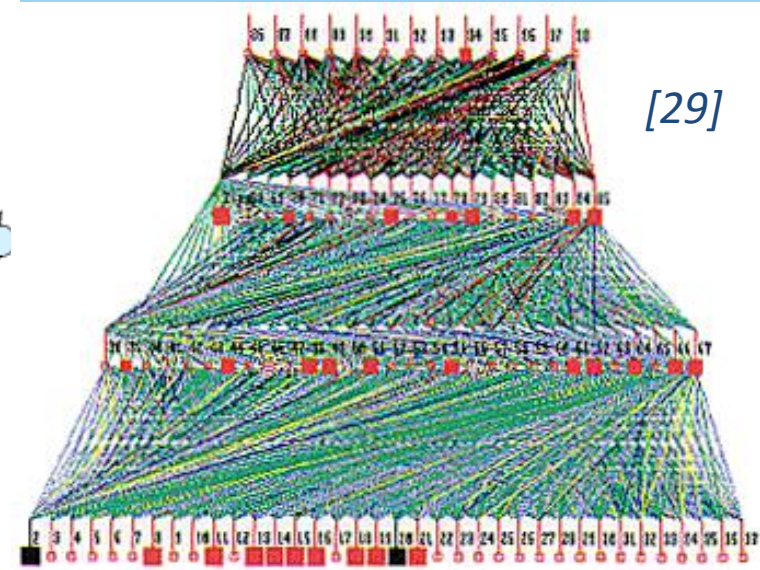
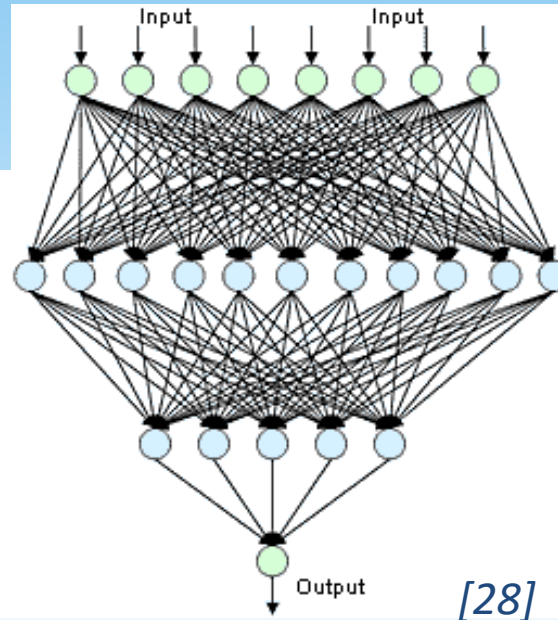
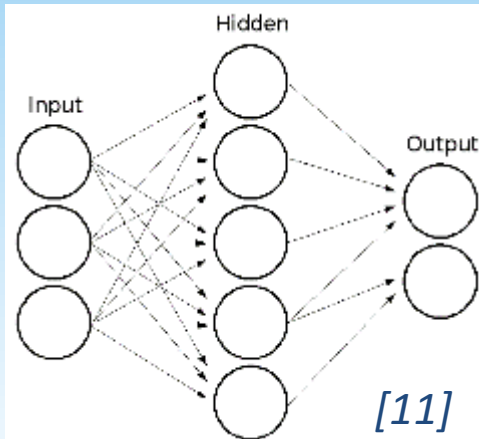
Class 6b  
Spiked Clockwise  
Broad Loop  
n = 51



# Artificial Neural Networks (ANNs)

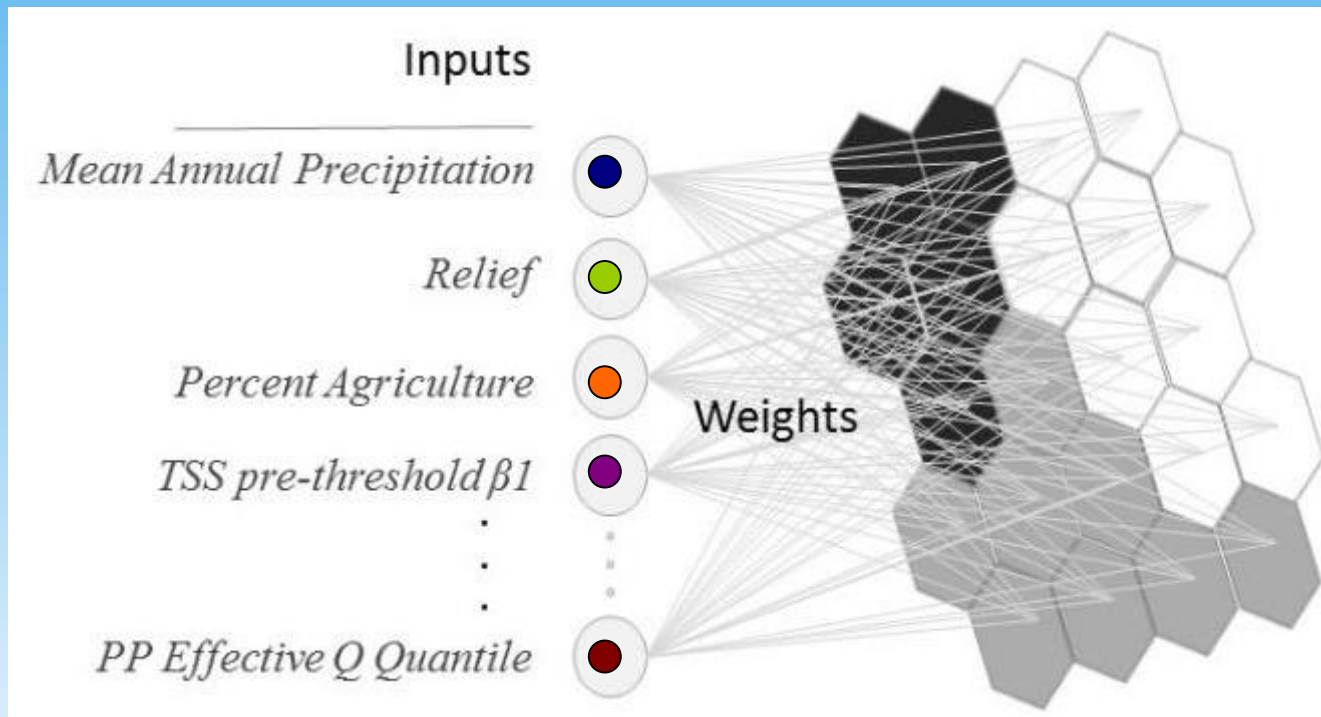
Different Types of ANNs are characterized by:

- Signal Types
- Interconnected Topology
- Weights/Activation Functions
- Updating methods

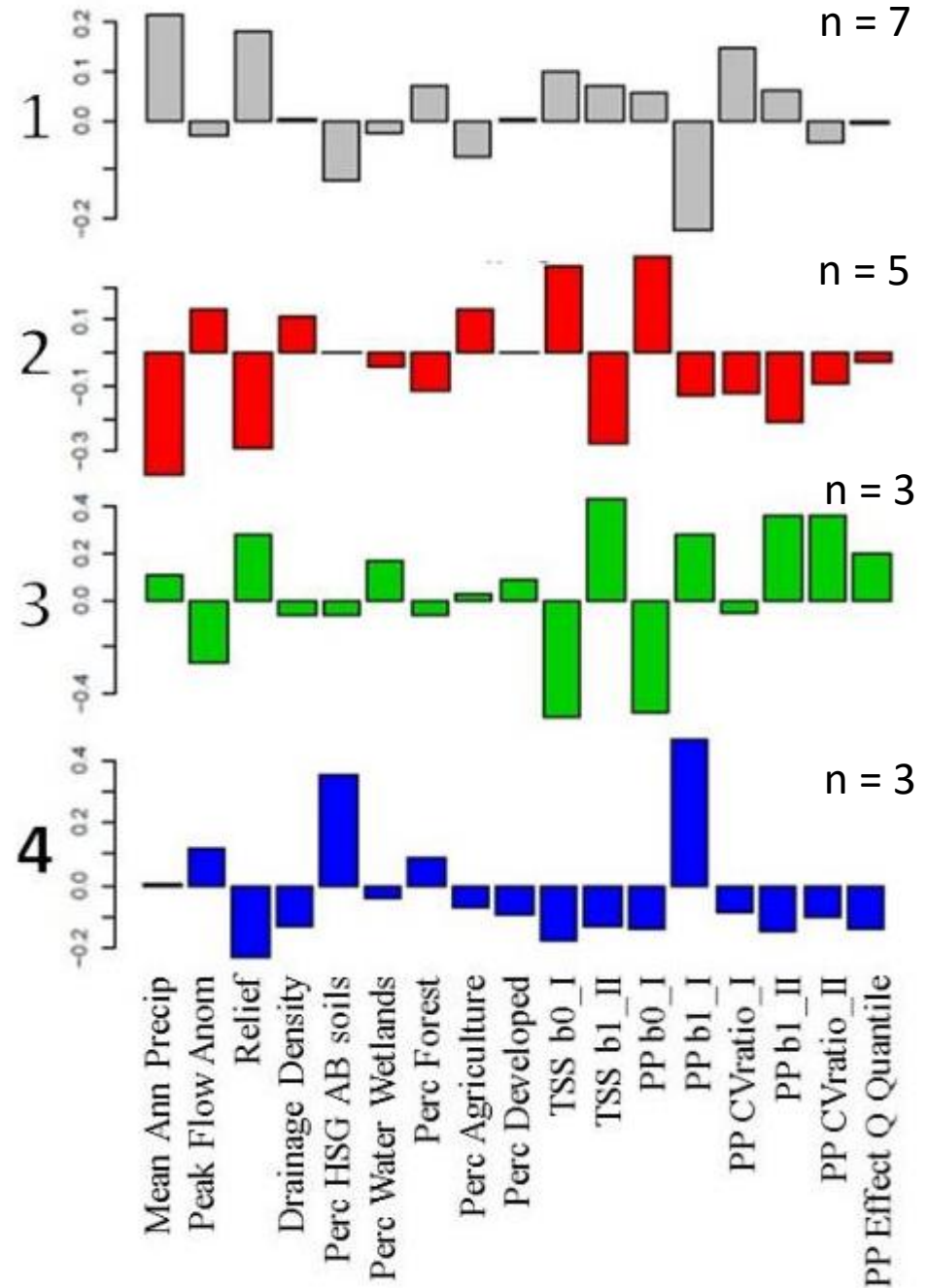
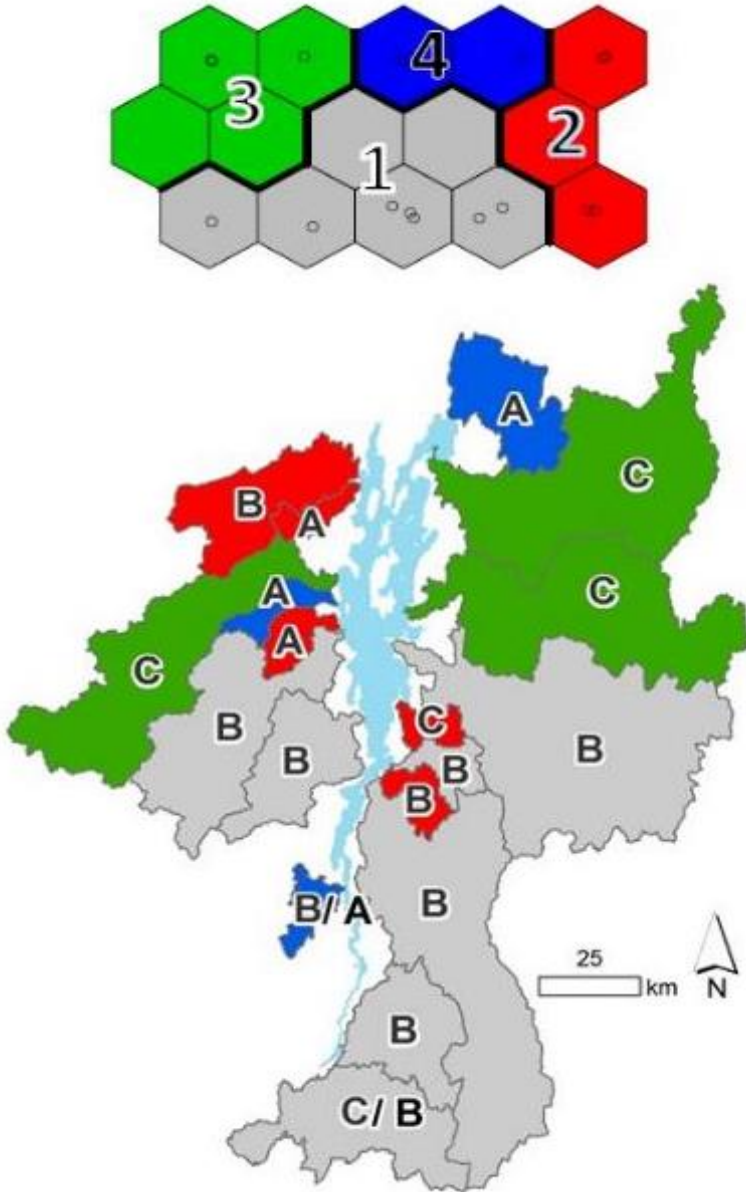


# Unsupervised Neural Networks

Output Space  
2D Map

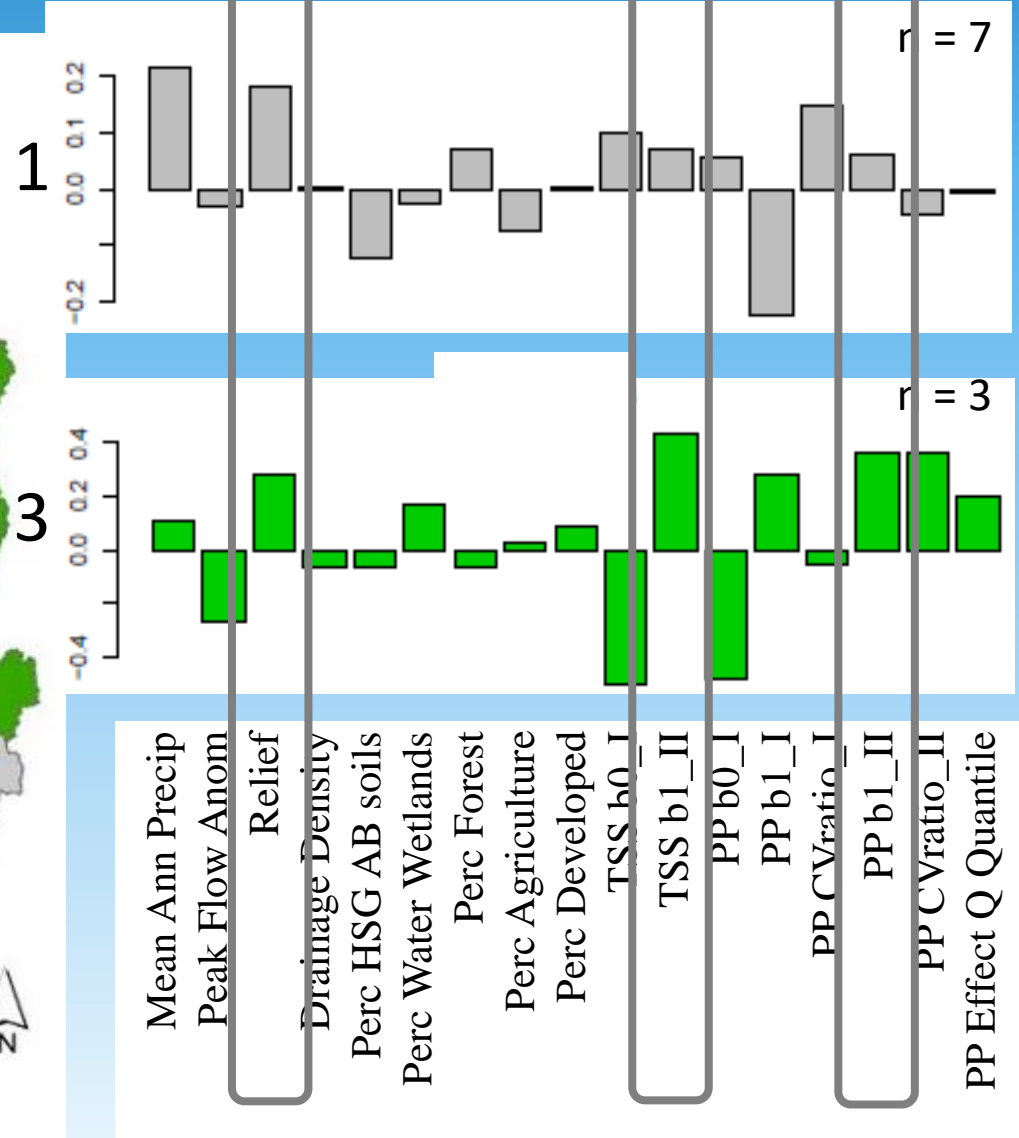
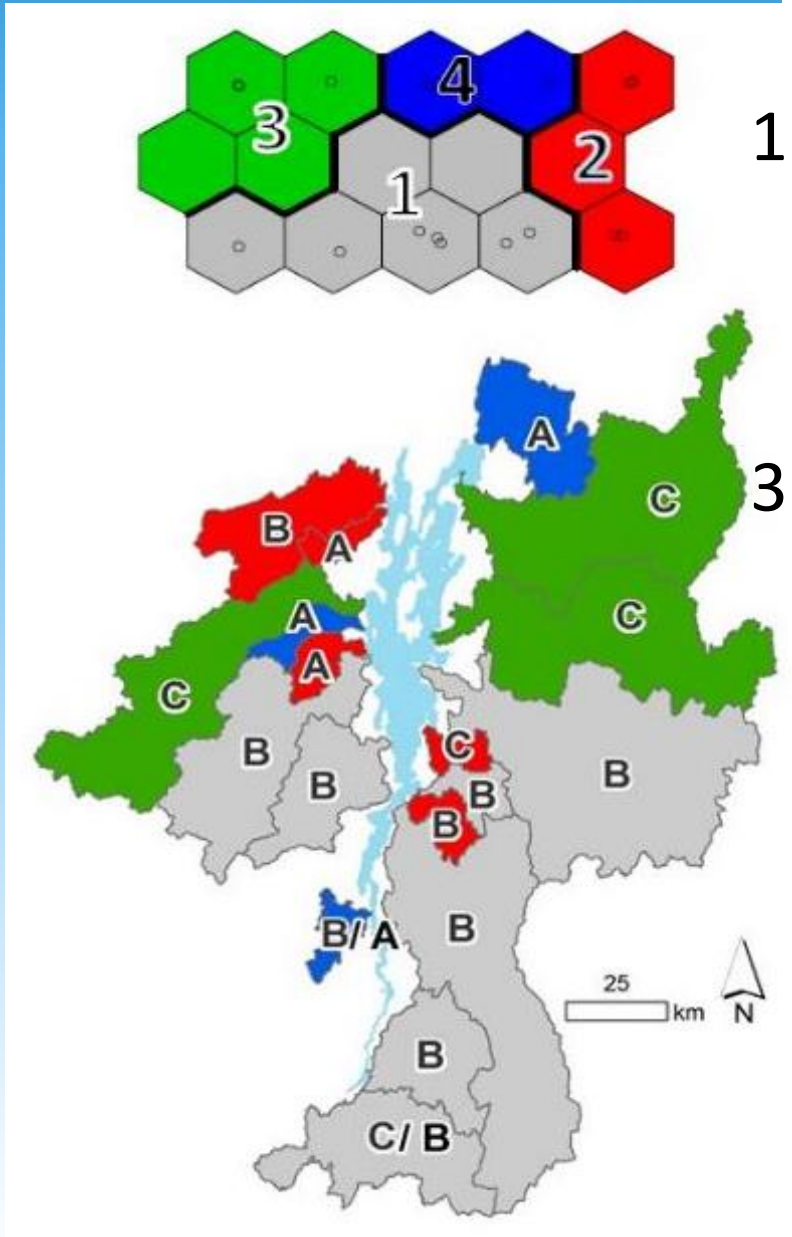


# Unsupervised ANNs



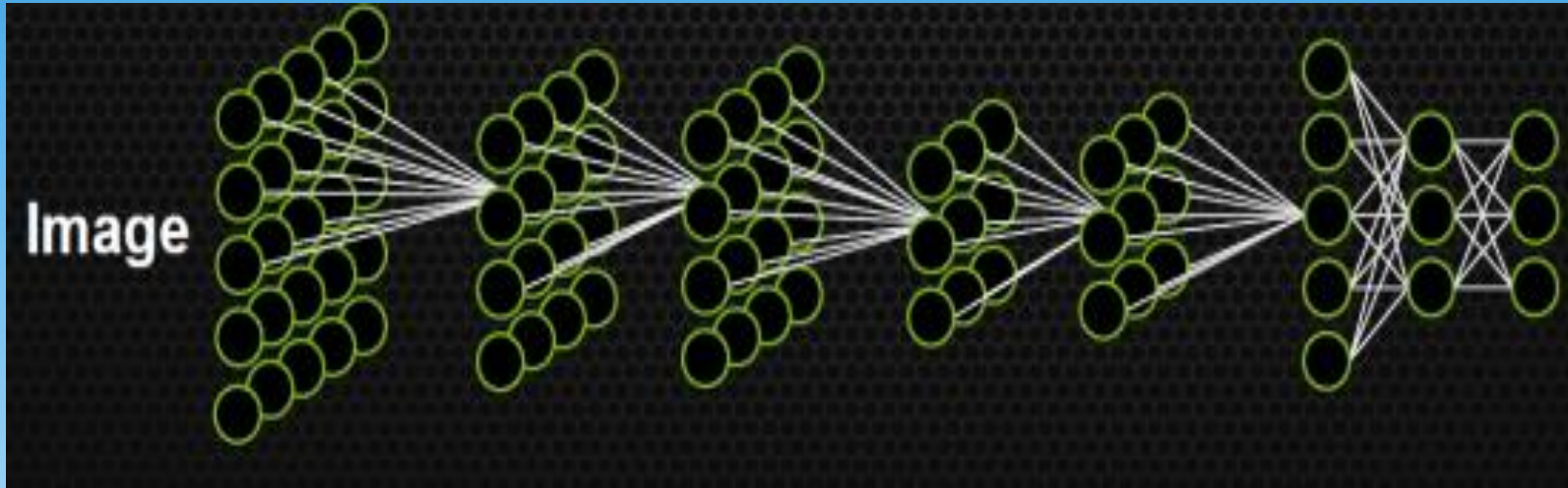


# Driving Variables

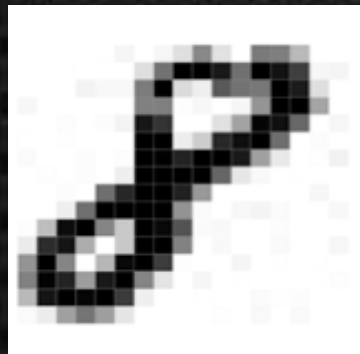




# Deep Learning Neural Nets



0	4	1	9	2	1
5	3	6	1	7	2
0	9	1	1	2	4
8	6	9	0	5	6
8	7	9	3	9	8
0	7	4	9	8	0
4	6	0	4	5	6
7	1	6	3	0	2
0	2	6	7	8	3
7	4	6	8	0	7



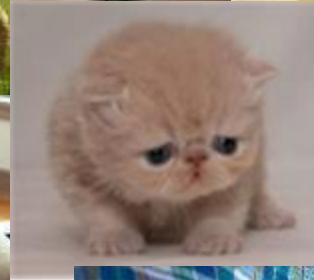
"Eight"

~~Not  
Eight~~

## Handwritten character recognition

# Deep Learning Neural Nets (DLNNs)

- Very successful in image processing:
  - Similarities to **visual cortex of brain**
- Google (DLNNs) cats



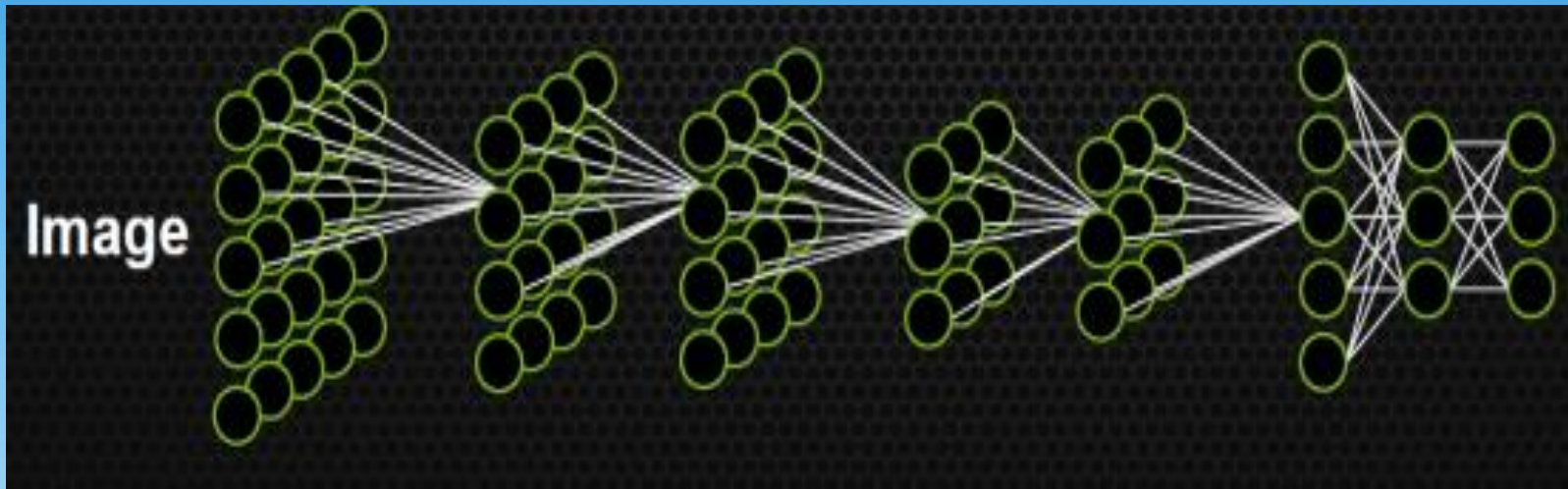
# Deep Learning Neural Nets (DLNNs)

- Very successful in image processing:
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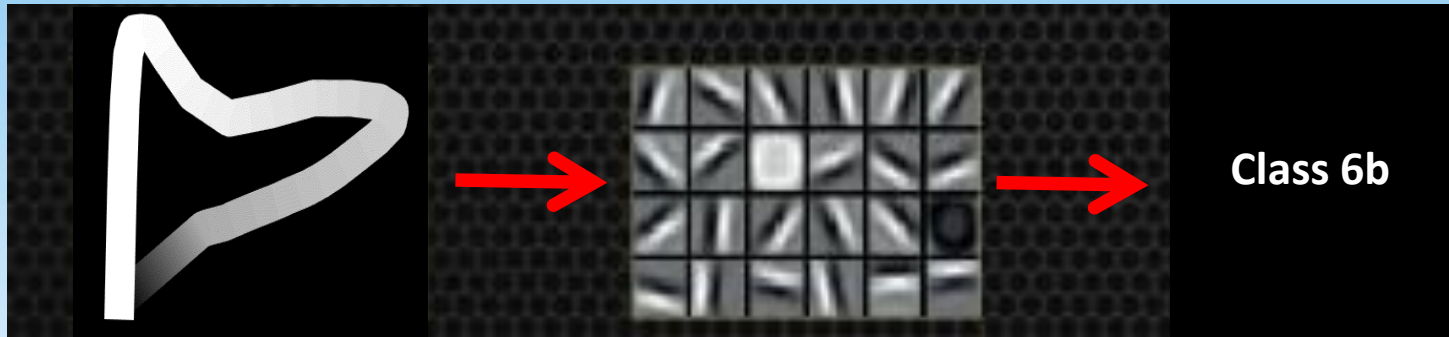




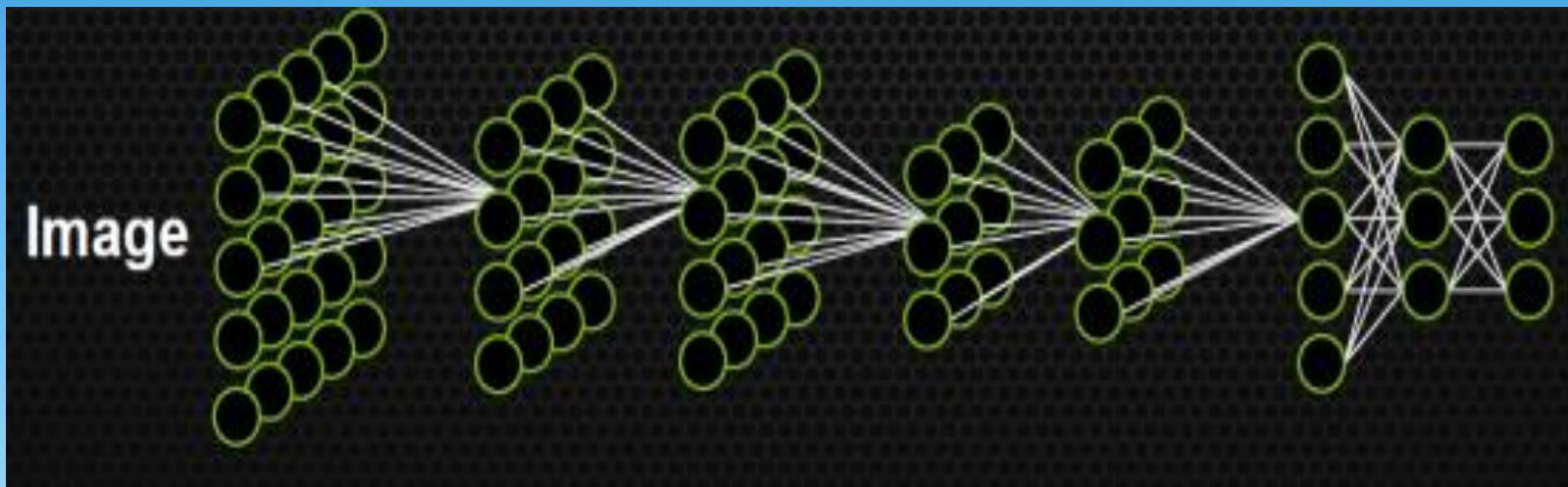
# Deep Learning Neural Nets



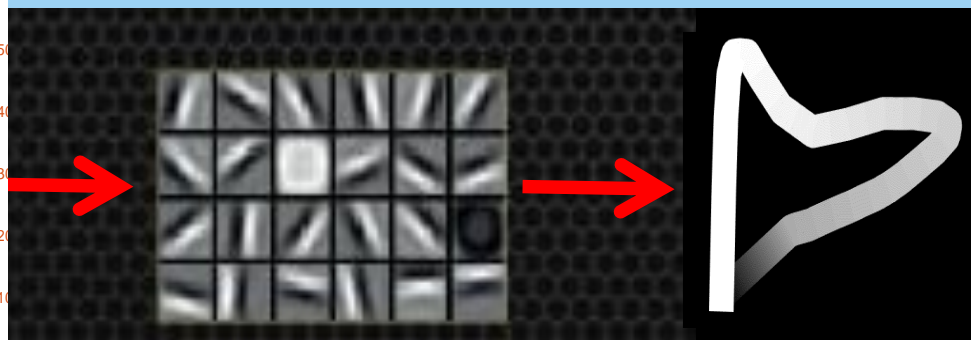
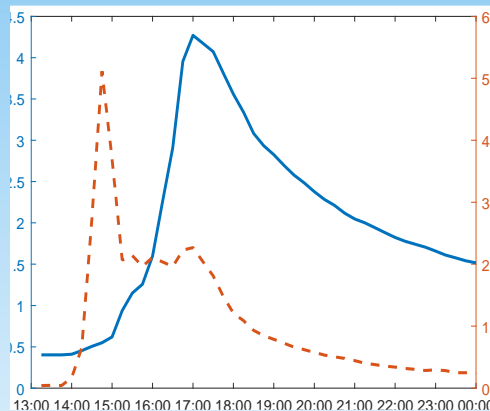
Hysteresis  
Images



# Deep Learning Neural Nets



Raw Sediment-  
Precipitation Data



Class 6b