Deep Learning & Data-Driven Approaches to Modeling Suspended Sediment Loads

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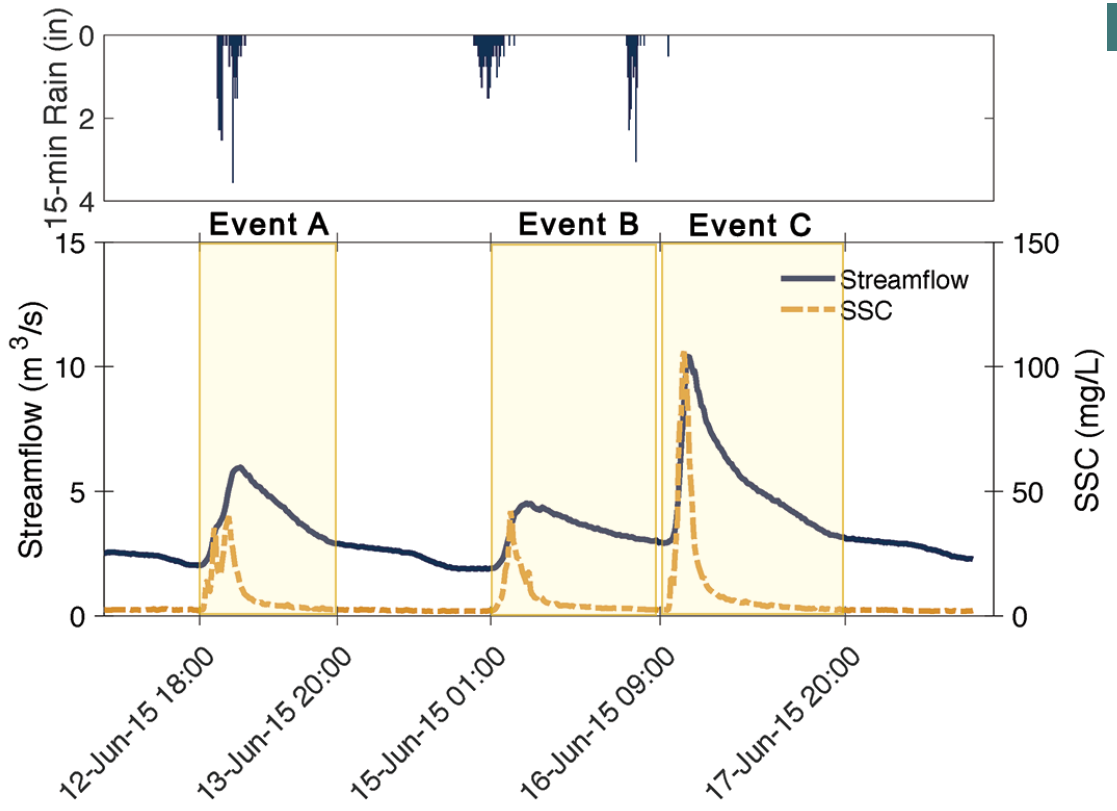
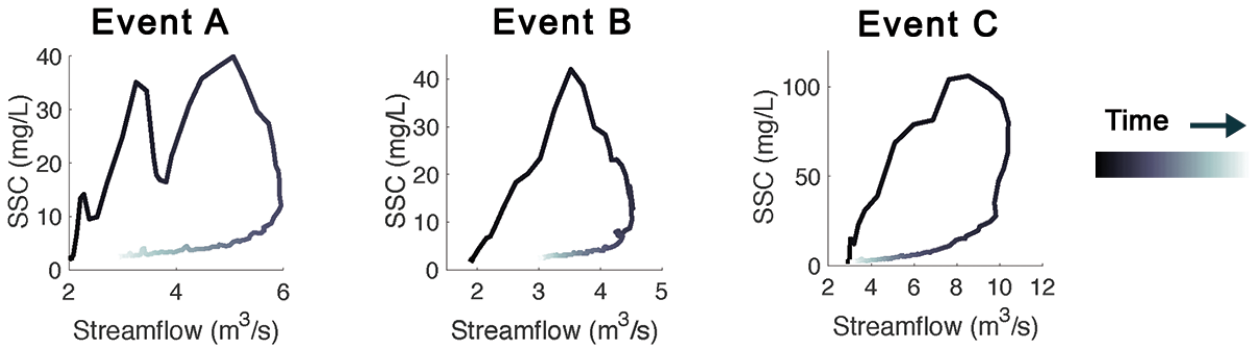
12-June-2018

BREE All Hands Meeting

The University of Vermont

Using Hysteresis Analysis to Characterize Hydrological Events

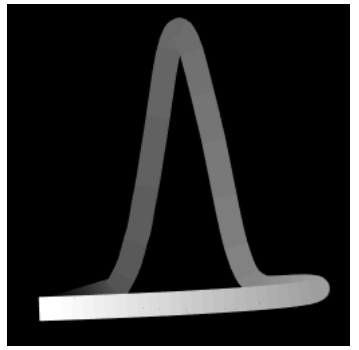




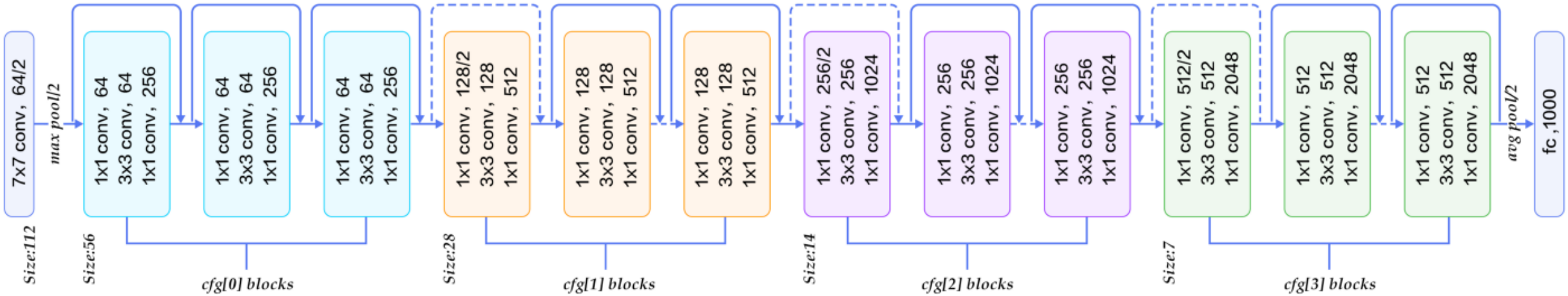
- Untapped potential in data-mining high-frequency data
  - **Automation w/ Deep Learning**
- Can improve constituent load estimates and guide modeling
  - **Watershed characterization**

State of the Art Deep Learning Implementations

- Model algorithms & architecture
  - Convolutional Neural Networks (CNNs)
  - 3-D CNNs
  - Autoencoders
  - Recurrent Neural Networks
  - Deep Belief Neural Networks



ResNet50 Architecture

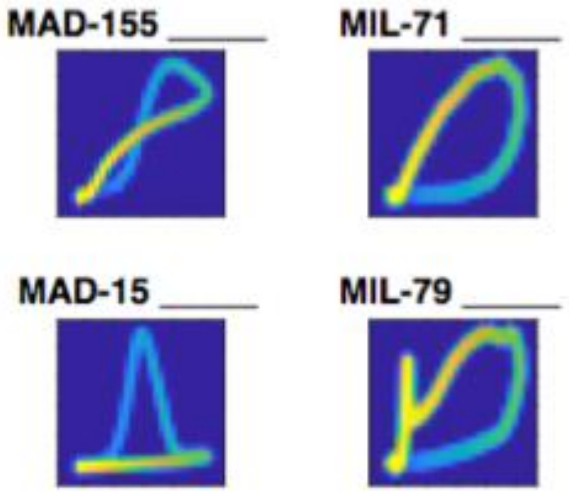


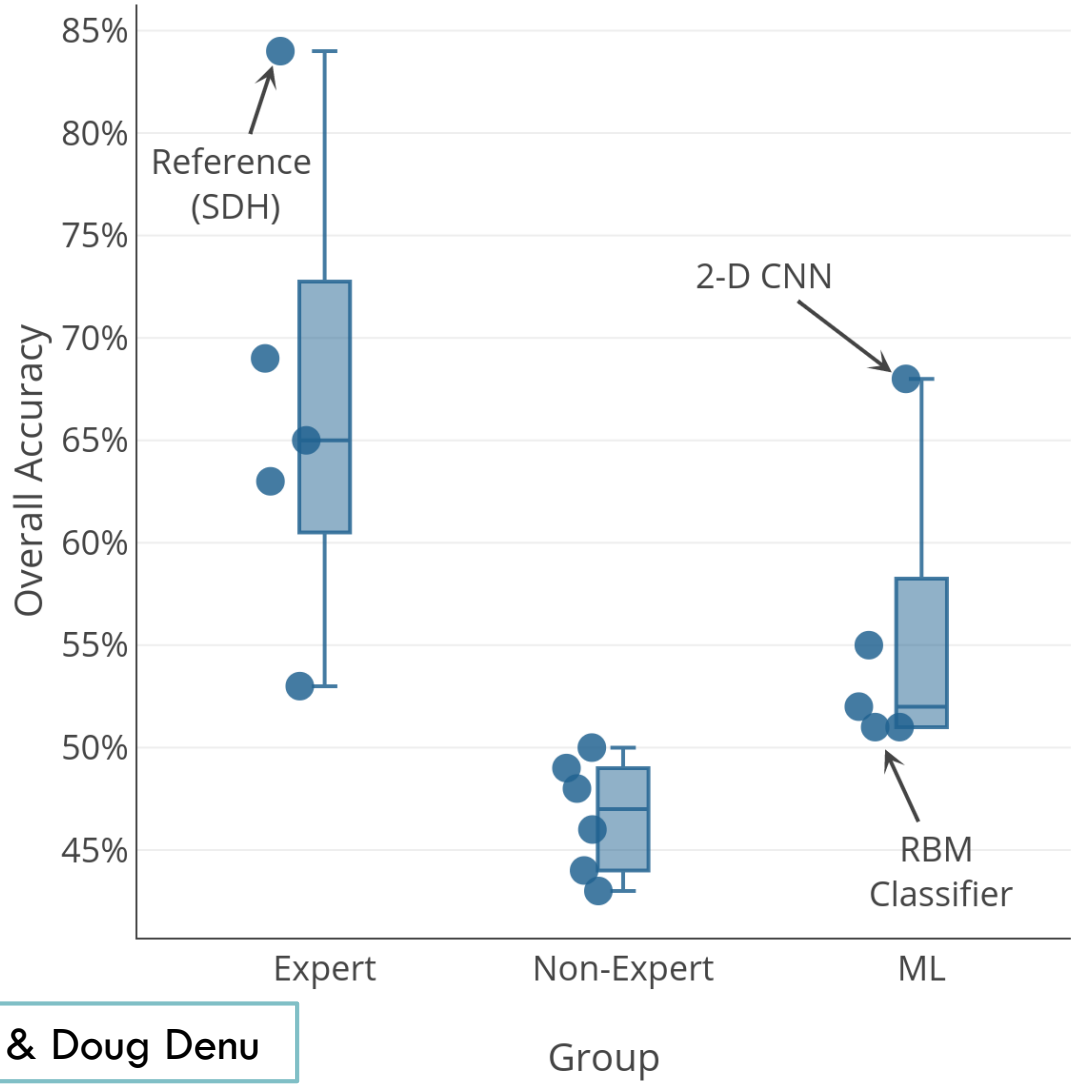
Kevin Andrew, Ali Javed, Maike Holthuijzen, Scott Turnbull, & Doug Denu

Comparison between human and machine learning classification of storm event hysteresis

- Highest Accuracy (68%) by 2-D Convolutional Neural Network
- Compare with human performance by crowdsourcing experiments

Can You Identify the Hysteresis Pattern?

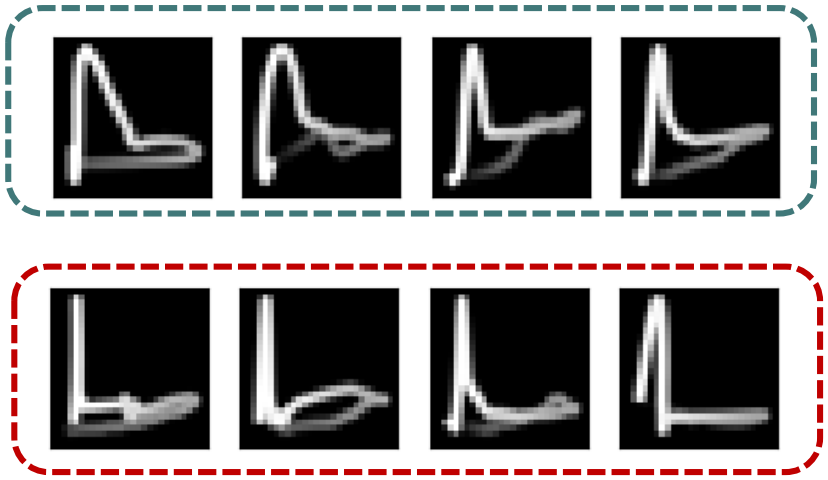




Maike Holthuijzen, Scott Turnbull, & Doug Denu

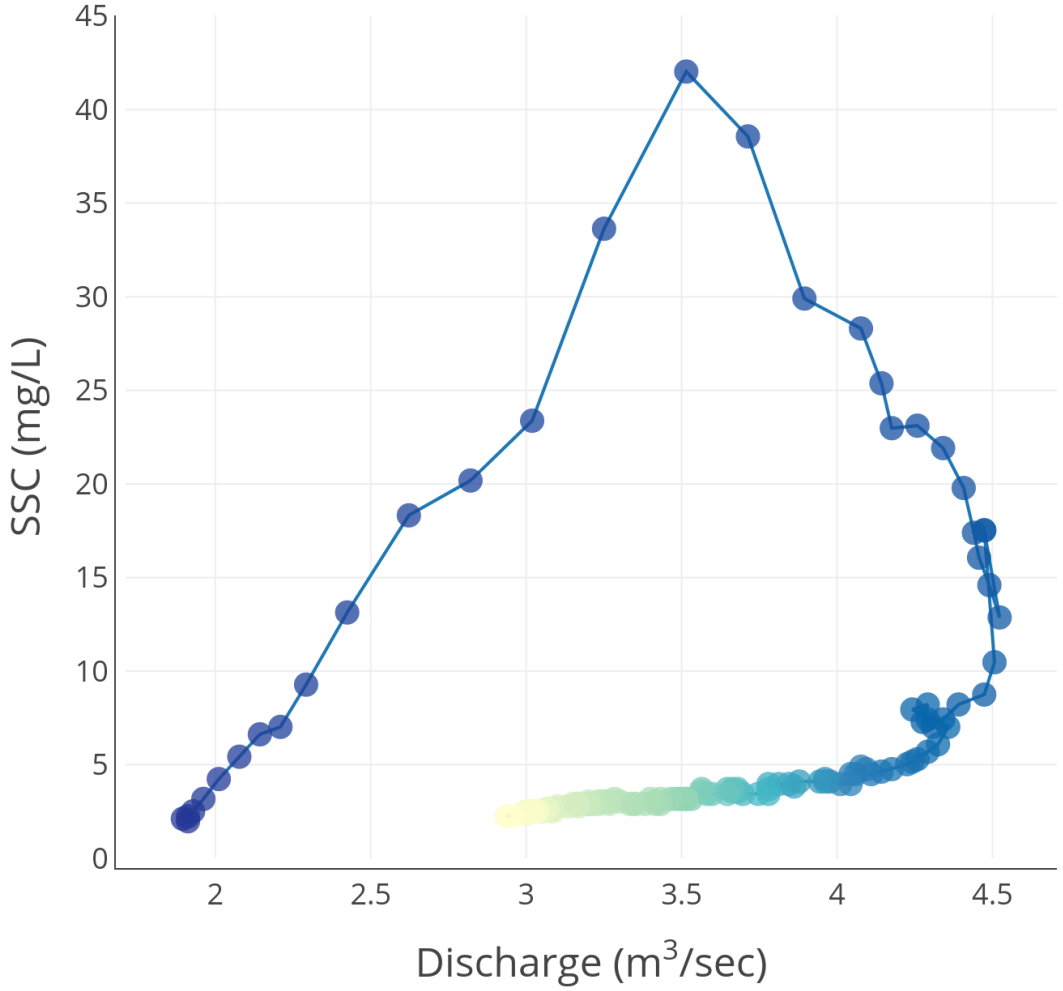
A Framework for Identifying New Event Types

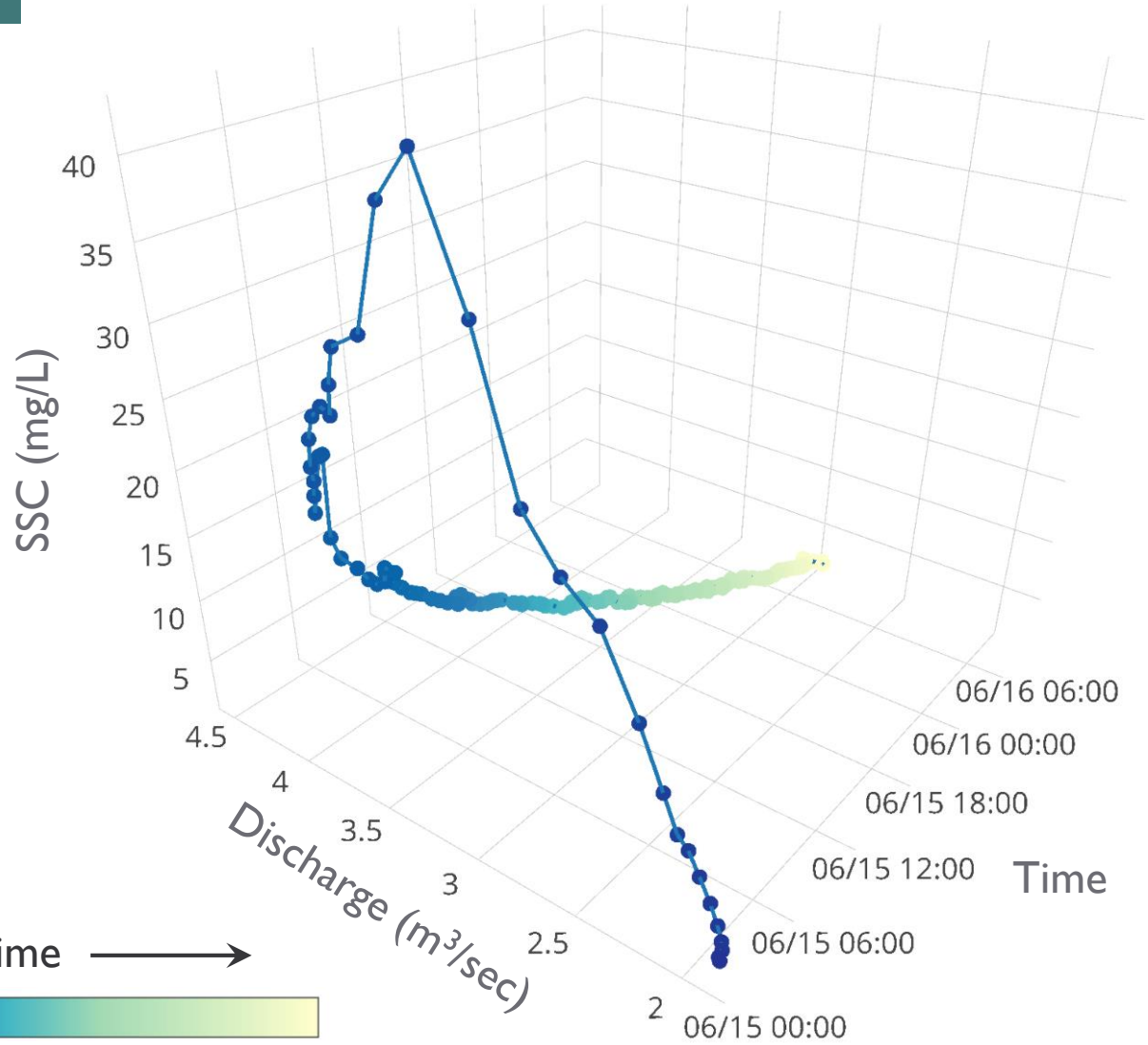
- Deep Learning for Feature Extraction
- Clustering of events
  - Visual patterns
  - Encoded features
  - Storm event metrics



- New pattern libraries for other hydrological variables
  - DOC
  - Nitrate
  - Soil moisture
  - Ground water level
  - Stream temperature

2-D vs 3-D "Trajectories" of Events

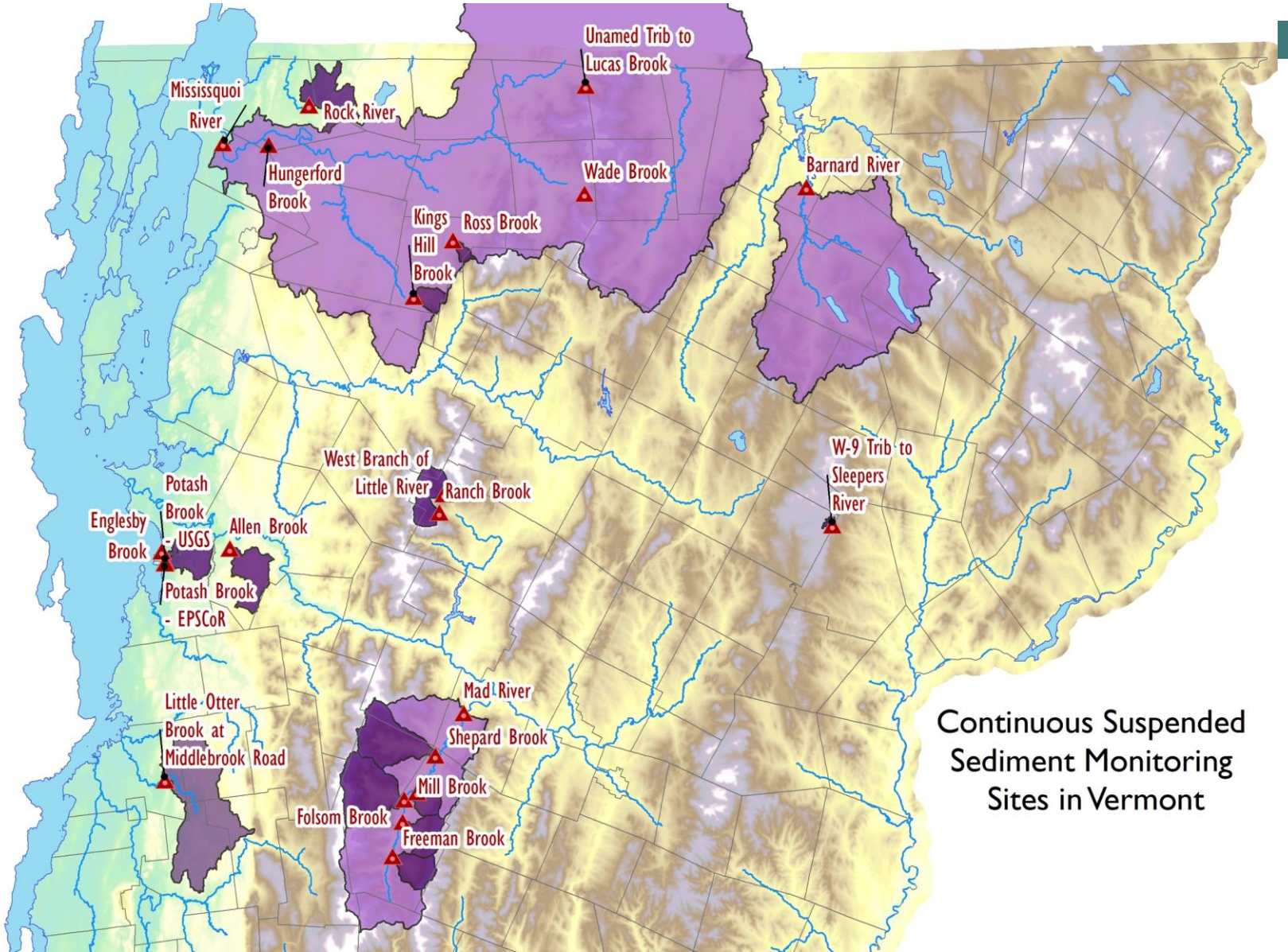




Time

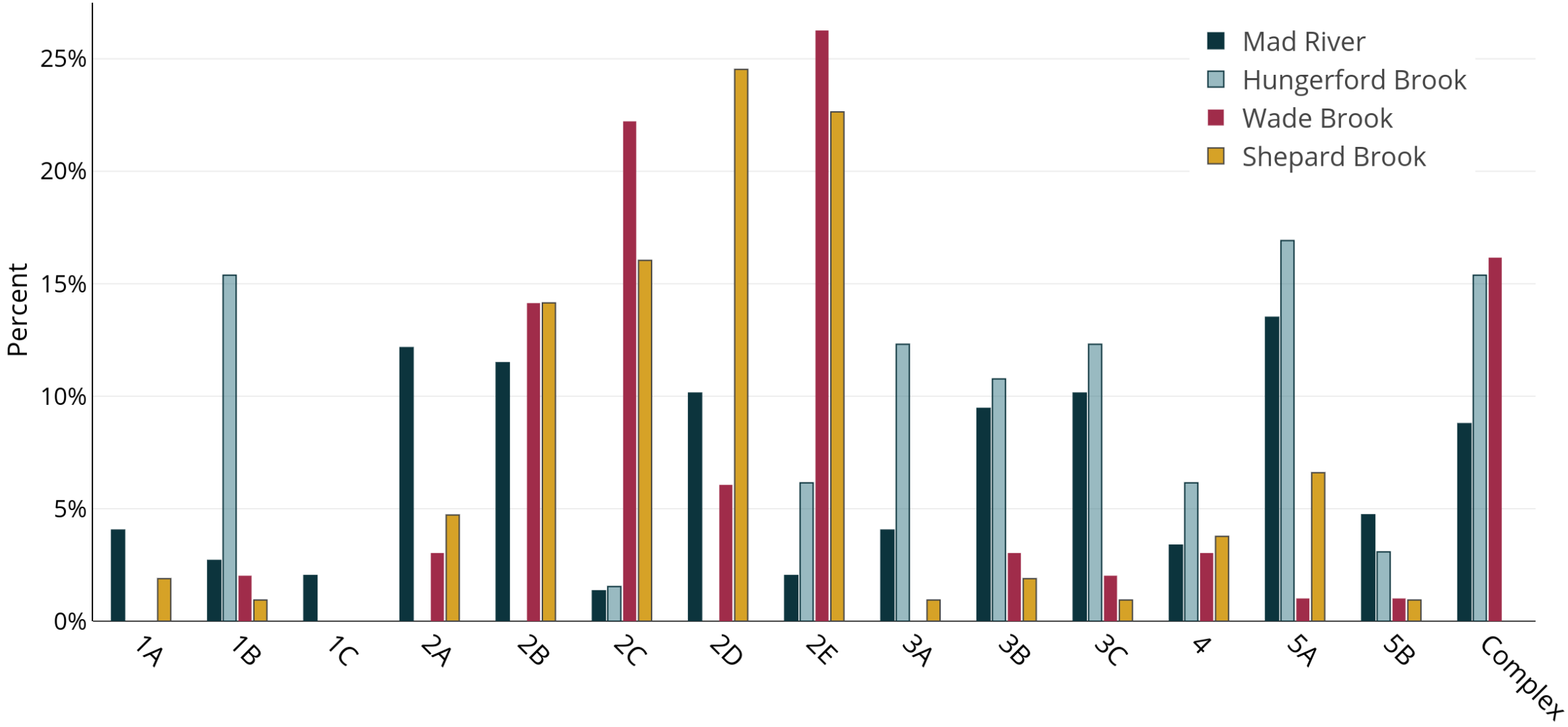
Expanding research out into new watersheds

- Range of:
  - Land Use/Cover
  - Geology
  - Soils
  - Drainage Area
  - Topography



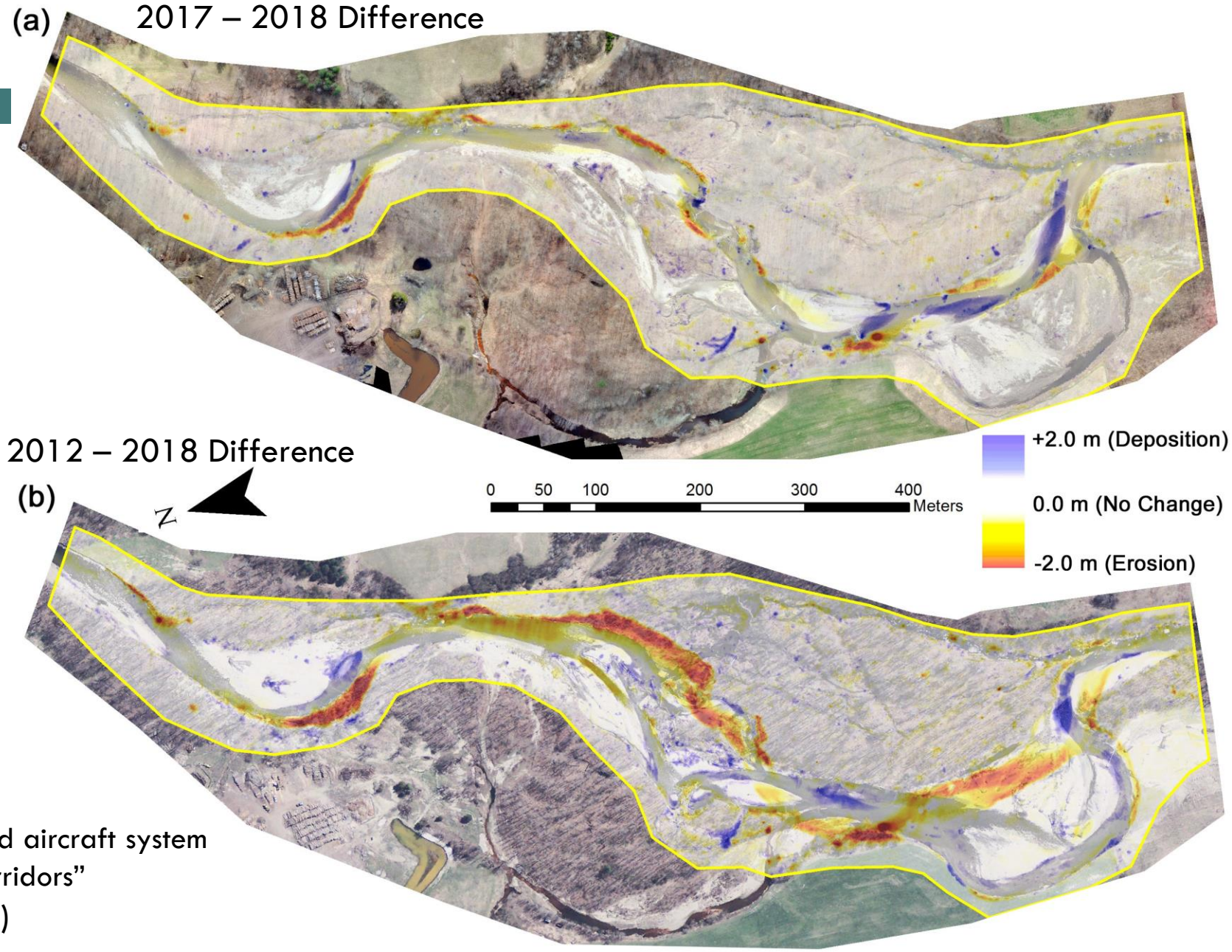
A more varied set of watersheds

Distribution of Hysteresis Patterns Varies Across Watershed Types



How can we effectively collect reach geomorphic data?

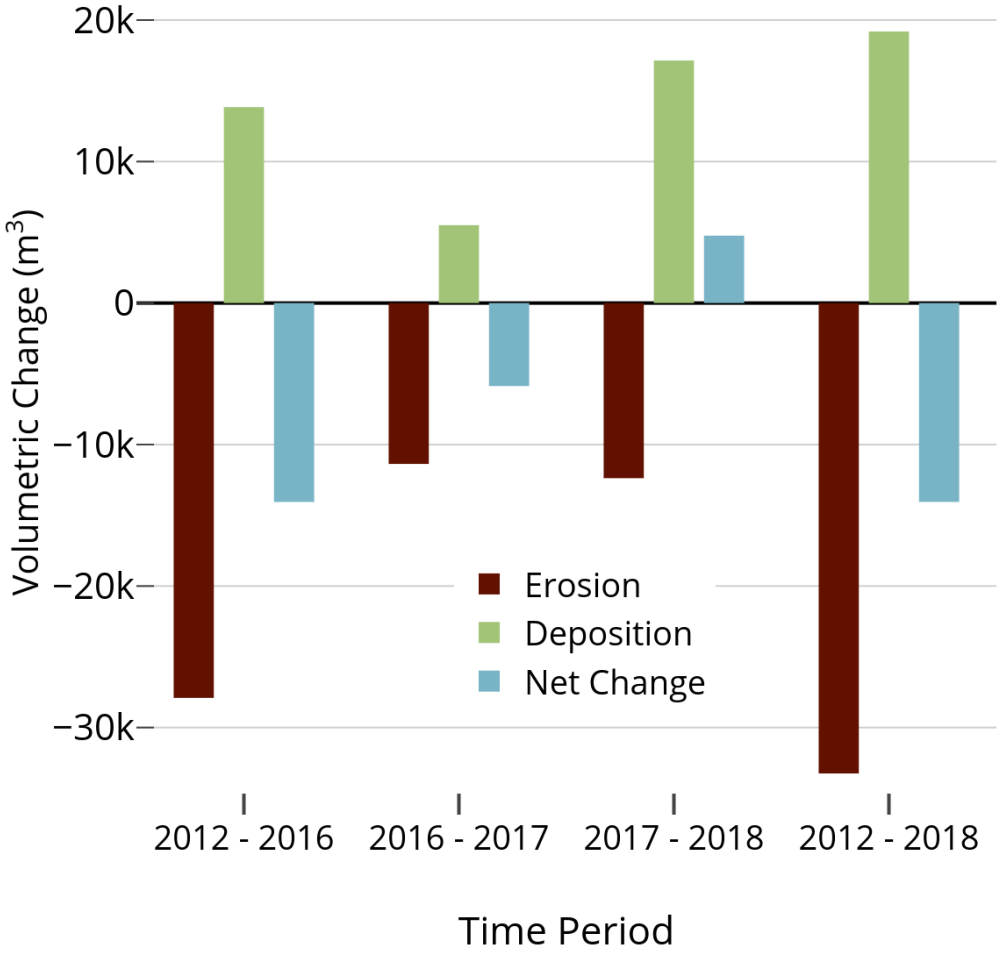
SenseFly eBee UAS



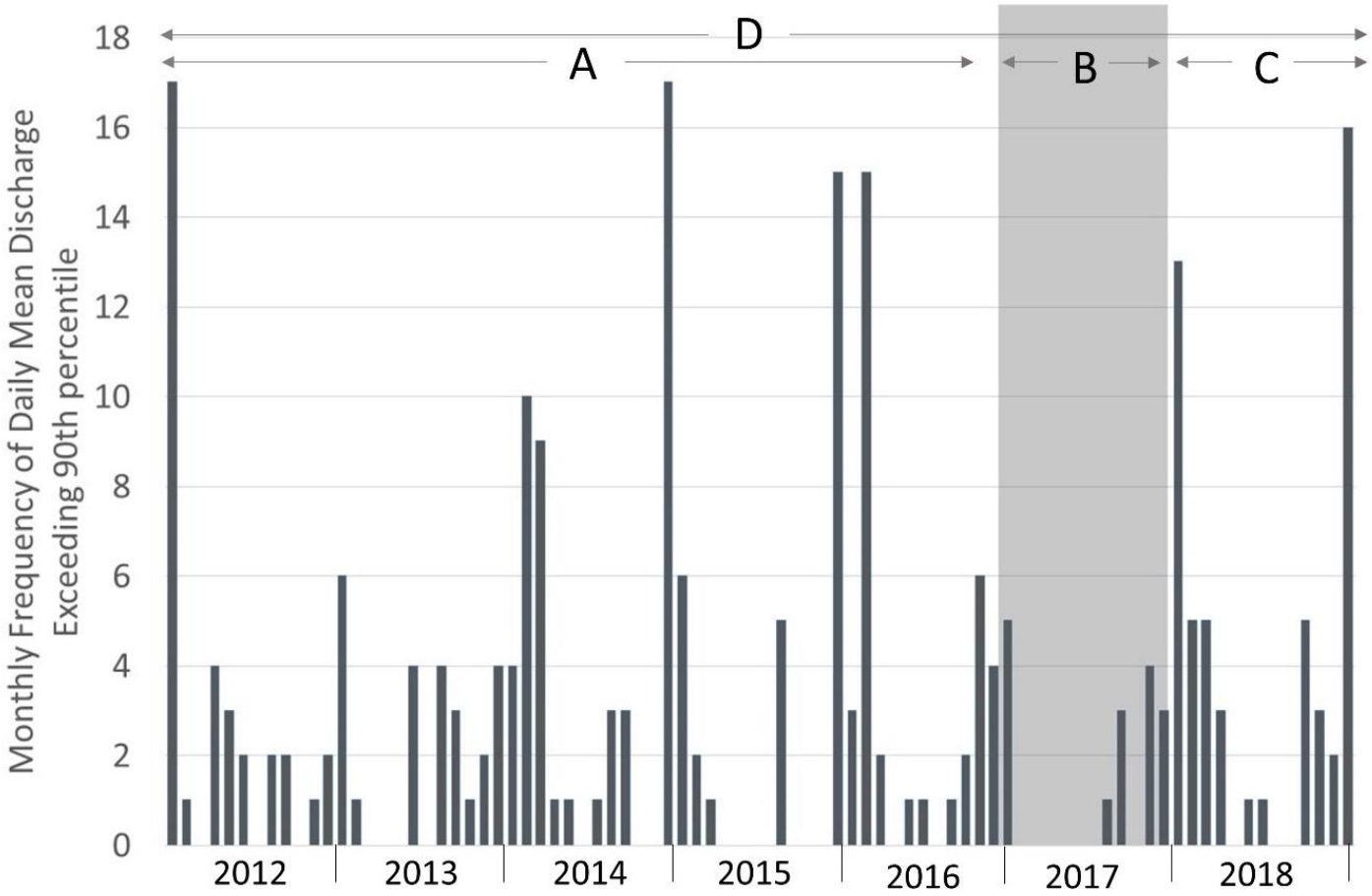
Hamshaw et al. (2018). "Application of unmanned aircraft system (UAS) for monitoring bank erosion along river corridors"
Geomatics, Natural Hazards, & Risk (In Press)

Analyzing Geomorphic Change and Sediment Transport Regimes

Volumetric Change within River Corridor area of New Haven River



Analysis of Streamflow above Threshold Value for Monitoring Intervals



Questions?

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BREE Basin Resilience to Extreme Events in the Lake Champlain Basin

NSF

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