Challenges of Monitoring Water Quality on a Continuous Basis at the Watershed Scale

Nicole Dobbs, Elizabeth Allen, Taylor Carter, François Birgand, Kyle Aveni-Deforge

Biological and Agricultural Engineering Department

Goal: Increase data frequency from that of typical automatic water quality sampling methods (flow proportional composite and discrete sampling) to improve water quality load estimates and define concentration dynamics at smaller temporal scales (event, seasonal) to better understand controlling biogeochemical and transport mechanisms of nutrient/sediment export in long-term water quality monitoring projects

Potential Solution Evaluated: Install a continuous (i.e. 15 min interval) automatic water quality monitoring system that can remain in the field and only requires periodic maintenance

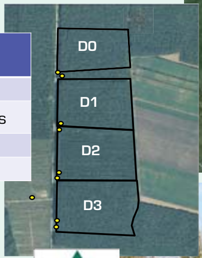
High-Frequency Measuring Instruments

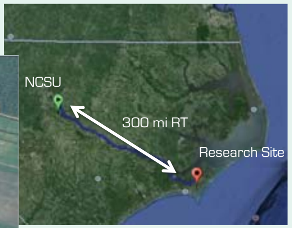
s::can UV-Vis spectrometer	Manta 2 multi-parameter probe
	
Measures light absorbance (λ = 220-750 nm) Light absorbance correlated to various constituents, i.e., nitrate, dissolved organic carbon, total organic carbon, turbidity	pH, temperature, specific conductivity, and colored dissolved organic matter fluorescence

Experimental Site: Carteret County, North Carolina

Four experimental watersheds, artificially drained

Watershed	Area (ha)	Treatment
D0	24.0	Young Pine
D1	24.7	Young Pine/ Switchgrass
D2	23.6	Mid-rotation Pine
D3	26.8	Switchgrass





Objective: quantify hydrological and water quality effects of switchgrass intercropping on pine plantations

How it works

1. Solar powered pumping system
2. Water pumped to instruments every 15 min, automated by Arduino program
3. Measurements taken and recorded internally
4. Water pumped back to stream
5. Lenses rinsed by automated cleaning system

Bi-weekly Maintenance

- Download data, collect discrete samples
- Scrub/soak s::can lenses with 2 - 5% HCl
- Scrub Manta sensors with detergent
- Periodically calibrate Manta sensors
- Sync instrument clocks

Additional data

Discrete samples collected every 14 hours

Analyze: carbon, nitrogen, and phosphorus species, sediment

More Instrumentation = More Potential Equipment Failures

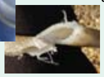
Mechanical

Tubing Disconnects

Parts aging

Broken Sensors

dlife Damage



Environmental

Lens Fouling

Freezing Temperature Sensitivity

Electrical

Arduino box: loose or misplaced wires

Low voltage

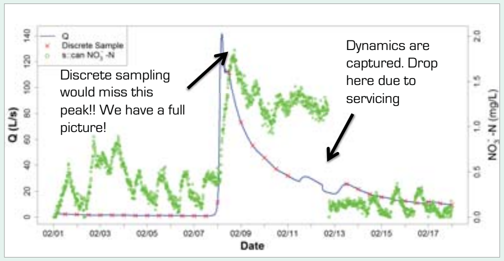
Damaged wires

Blown fuse

Condensation inside of lens

Purpose of High-Resolution Data:

Use partial least squares regression (PLSR) to predict concentrations of constituents based on correlation between low-frequency (discrete samples) and high-frequency data. Various constituents are associated with a particular absorptions spectra. Based on the absorption spectra provided by the s::can, we can predict concentrations correlated with specific wavelengths. Based on local calibration, we can predict water quality constituent concentrations on a continuous basis.



Pros

- High resolution data
- Capture system dynamics more fully
- Reduce lab analyses
- Combine high-resolution data and discrete analyses to predict concentrations of other constituents

Cons

- Expensive equipment
- Extensive routine maintenance
- Increased chances of equipment failure
- Still need to collect discrete samples in order to do initial calibration and as backup

Suggestions for Improving Data Quality

- Tubing insulation for freezing conditions
- Increase power supply (additional battery)
- Transmit data via website (reduce travel, monitor data continuously)
- Increase data storage capacity
- Improve automated optics cleaning procedure with lens brushing or automated HCl solution cleaning

Is it worth it?

Conclusion: Yes!

When the system is working, we are able to capture a fuller picture of the dynamics at play, without having to rely on lab analysis of discrete samples.

Please visit our lab