Baseflow and storm-based water quality: from observations to urban stream imagery analysis

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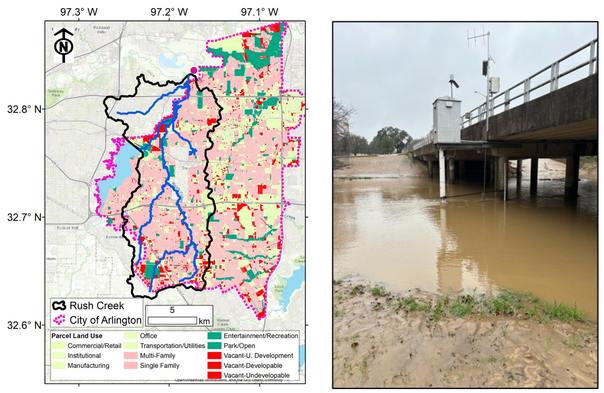
I. Research Goal

Analyze baseflow and storm-based samples from a highly altered urban stream for various substances including nitrate, iron, phosphorous, total organic carbon, tannin-lignin, and turbidity to train a machine-learning model and evaluate solute and contaminant transport from high-resolution stream imagery.

II. Research Questions

1. What are the dominant concentration-discharge patterns (C-Q) in a highly-altered urban stream?
   - **Dilution, chemostasis, mobilization**
2. What are the main drivers controlling solute and contaminant transport in a highly-altered urban stream?

III. Study Site



- **Stream gauge station at Rush Creek :** 126 km² and runs from S to N across the City of Arlington, TX
- **Dallas-Fort Worth Metroplex:** 4th largest metropolitan area in the US (7.5 million people).
- **Mean annual precipitation:** ~1,000 mm/yr (sub-humid tropical climate)
- **Clay loam soils:** with up to 37% in clay content.
- The area mainly comprises **residential use (49%).**
- Infrastructure related to commerce, industry, transportation, and parking lots covers 31.6%. Parks and vacant parcels comprise 9.9 and 9.8%, respectively.

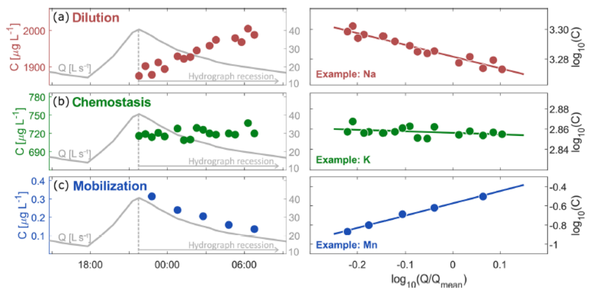
IV. Methods

- Baseflow and storm-based water sampling
- Sample preparation and digestion
- Colorimetric analysis
- Discharge measurements
- Image Retrieval

DRB200

Hach DR900 Multiparameter Colorimeter

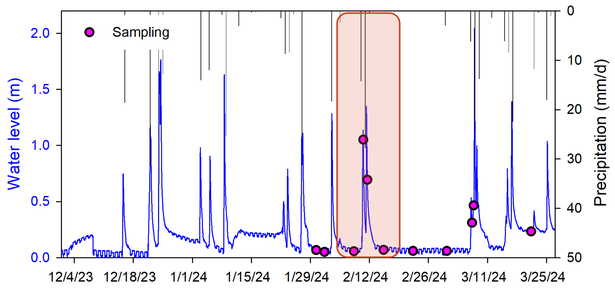
Phosphorous Iron Nitrate



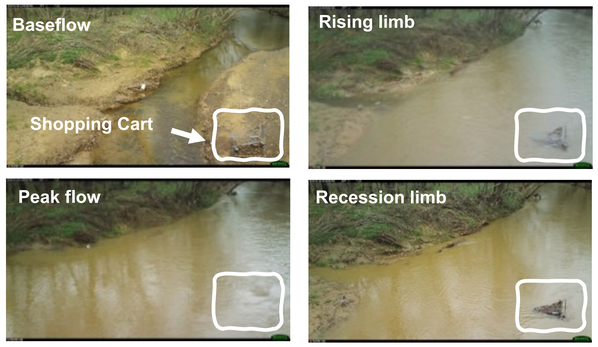
Common C-Q patterns (Knapp et al., 2020)

V. Results

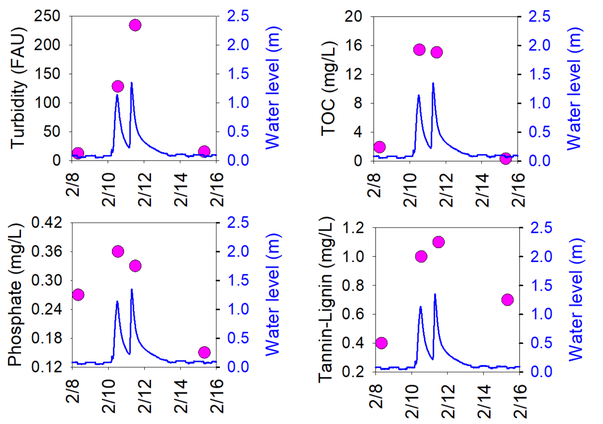
Stage height, precipitation, and sampling



GaugeCam Imagery

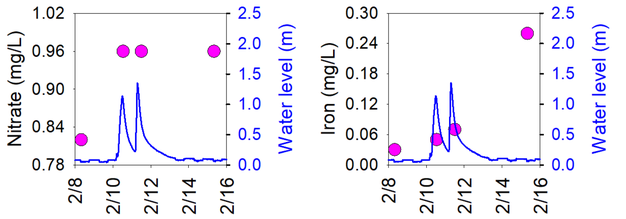


Mobilization



The above graphs indicate mobilization patterns for turbidity, total organic carbon (TOC), phosphate, and tannin-lignin. The concentration of these features show a direct correlation likely due to sediment transport into the catchment .

Chemostasis-Dilution



The above graphs have similar characteristics to chemostasis and dilution patterns. The patterns of these features indicate that they have consistent sources and transport is not impacted by urban runoff.

VI. Key finding

- Convective events (> 1 in) triggered a significant stream response coupled with sediment, solute, and contaminant transport.
- TOC, Tannin-Lignin, Phosphate, and Turbidity exhibited a mobilization pattern favored by sediment mobilization.
- Nitrate and dissolved iron were characterized by chemostasis and dilution patterns.

VII. Next Steps

- By coupling water quality data with stream imagery, we plan to train a machine-learning model to predict water quality based on water-color variations using HSV Color Scale.
- Future sampling will improve this model and reduce the need to manually collect and test each sample for its chemical content.

Acknowledgments

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Reference cited:

Knapp, J. L., von Freyberg, J., Studer, B., et al. (2020). Concentration–discharge relationships vary among hydrological events, reflecting differences in event characteristics. Hydrology and Earth System Sciences, 24(5), 2561-2576.

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