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Undergraduate Research Posters

Effects of Filtration Techniques in Identifying Dissolved Reactive Phosphorus versus Particulates in South Tobacco Creek Watershed

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Abstract

Various research centers, scientists and professionals in analytical chemistry use different types of filter papers to determine the types of phosphorus (P) and particulates responsible for algal blooms and eutrophication in water bodies. However, those filter papers misinterpret results in defining dissolved reactive phosphorus (DRP) versus particulates, by ignoring the fact that particulates which could be enriched in phosphorus (P) or nitrogen (N) present in the water also contribute to eutrophication.

Effects of Filtration Techniques in Identifying Dissolved Reactive Phosphorus versus Particulates in South Tobacco Creek Watershed

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Introduction

Various research centers, scientists and professionals in analytical chemistry use different types of filter papers to determine the types of phosphorus (P) and particulates responsible for algal blooms and eutrophication in water bodies. However, those filter papers misinterpret results in defining dissolved reactive phosphorus (DRP) versus particulates, by ignoring the fact that particulates which could be enriched in phosphorus (P) or nitrogen (N) present in the water also contribute to eutrophication.

Fig 1. The STC watershed

Objectives

The goals of this research are:

- To determine whether particulates pass through six different filter papers and to prove that DRP is not truly dissolved P, but also contains particulates that contribute to eutrophication,
- To quantify and index particulates that pass through the filter papers,
- To demonstrate that sediments move from one source to another through trends in sediment transport in water bodies.

Study Area

South Tobacco Creek (STC) watershed, located near the town of Miami, in the south-western region of Manitoba, Canada, was the selected study area. It is an ideal study area since most of the land in this watershed is used for agricultural production, including: cereal crops, oilseeds, perennial forages and livestock; which drains into the Red River and then, up-north into Lake Winnipeg. The STC contains two sub-watersheds, and more specifically, a reservoir located in the Madill sub-watershed was the selected site for water sample collection.

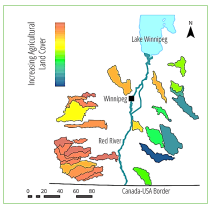

Fig 2. Flow of water from agricultural land.

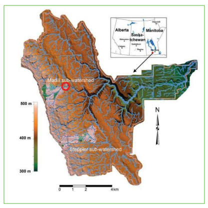

Fig 3. Selected study area circled in red.

Methods

- Fresh homogeneous water samples were collected in the Madill sub-watershed, at 2 locations, namely the "Inlet" and the "Outlet",
- Filtration experiments were conducted in the lab, using six filter papers: 1.6, 1.5, 1.2, 0.8, 0.45 and 0.2 µm, by filtering duplicate 1 L of water through each filter paper, and the samples were labelled: Sample ID 1-12.
- The filtered samples were collected and oven-dried for 18 hours,
- After 18 hours, Gravimetric Analysis was performed to quantify and index Total Suspended Sediments (TSS) present in the water samples,
- The filtrates were refrigerated at T = 4°C; and were then analyzed for the presence of:
  - Particle size distribution via a Master Sizer 2000 Analyzer;
  - P and N by Colorimetry via a Lachat Flow Injection Analyzer.

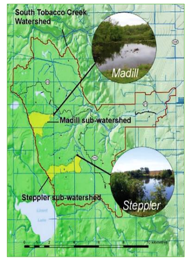

Fig 4. A reservoir located in the Madill sub-watershed was the selected study site.

Results & Discussion

The relationship between Total Suspended Sediments (TSS) and Turbidity in the inlet versus the outlet obtained by Gravimetric Analysis is represented in Fig 5. The trends indicate movement of sediments, where the water sub-samples after filtration, respective to their filter papers, contain more TSS and are more turbid in the outlet than in the inlet.

Table 1. Comparison of TSS in inlet v/s outlet

Filter paper (µm)	Inlet TSS (mg/L)	Outlet TSS (mg/L)
1.6	0.6972	0.9139
1.6	0.6140	0.9747
1.5	0.6803	1.0896
1.5	0.2537	1.0537
1.2	0.6729	0.8488
1.2	0.7045	1.1215
0.8	0.6844	0.9724
0.8	0.7075	1.0457
0.45	0.7701	1.2449
0.45	0.7545	1.3274
0.2	0.7515	1.2616
0.2	0.7800	1.5424

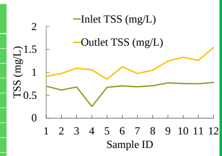

Fig 5. TSS and turbidity are significantly higher in the outlet than in the inlet.

From the largest (1.6 µm) to the smallest (0.2 µm) pore sizes, concentrations of both TSS and turbidity significantly increase as shown in Table 1; from top to bottom.

The relationship between DRP and particulates, obtained from the Lachat Analyzer for the inlet and the outlet are represented in Fig 6 and Fig 7 respectively. For both locations, results show that concentrations of NO_3/NO_2 are significantly lower than concentrations of both P and NH_3. However, the inlet contains the highest concentrations of NH_3 whereas the outlet contains the highest concentrations of P.

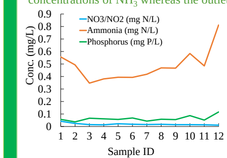

Fig 6. Conc. of P, NO_3/NO_2 and NH_3 for the inlet filtered sub-samples

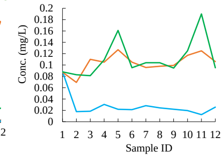

Fig 7. Conc. of P, NO_3/NO_2 and NH_3 for the outlet filtered sub-samples

The relationship between filtered samples and particulates acquired by a Master Sizer 2000 are shown in Fig 8 and Fig 9, for the inlet and outlet respectively. Fig 8. shows that the inlet filtered samples contain sediments of silt and sand, whereas those for the outlet are sediments of silt, since they are all < 50 µm that have been identified to pass through the filter papers. The inlet could be the source of sediments where P also come from.

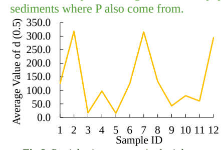

Fig 8. Particle sizes present in the inlet water sub-samples.

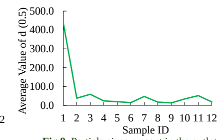

Fig 9. Particle sizes present in the outlet water sub-samples

Conclusions

- Nutrients such as P, NO_3/NO_2 and NH_3 have been identified to be present, that pass through the filter papers and that contribute to DRP fluxes in the outlet.
- More sediments were detected in the outlet water samples, which could be due to increased levels of organic material due to the presence of aquatic vegetation.
- Higher conc. of P were detected in the outlet; hence, particulates that pass through the filter papers are not truly dissolved P, but enriched in P, NO_3/NO_2 and NH_3.

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