Potential for Phosphorus Release in Streambank Soils of Different Land Uses in the Missisquoi River (Vermont, USA)

The University of Vermont

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INTRODUCTION

- Algae blooms have become a worldwide issue in lakes and fresh water bodies, affecting drinking water and recreational activities. In Lake Champlain, their growth is limited by the concentration of phosphorus (P) and nitrogen in its waters.

- Due to the predominant contribution of streambank erosion from lands adjacent to the streams and rivers that flow into Lake Champlain, it is important to determine the role of streambanks –as sinks or sources of P– in one of the most affected areas of the Lake Champlain Basin: the Missisquoi River watershed (Fig. 1a).

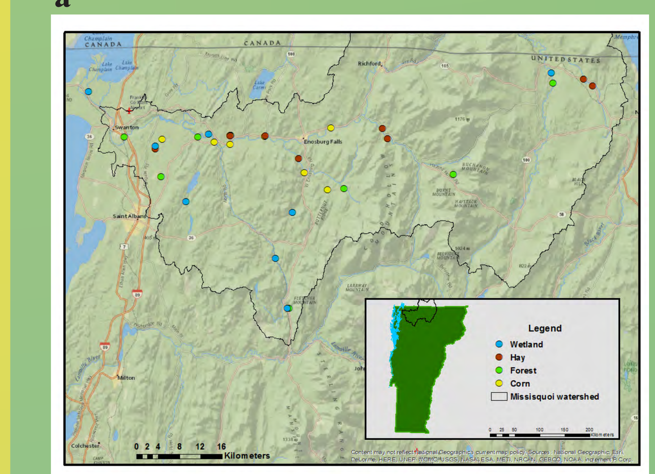
- Land use can significantly influence the amount of P that can be discharged into nearby streams: the use of fertilizers and manure in crops incorporates high amounts of P into the soil, while other land uses, such as forests, only have natural inputs.

GOAL

We present here P concentrations and measurements of its saturation in the soil in streambanks and their corresponding interior land use along the Missisquoi River and its tributaries, looking at four different land uses: forest, wetlands, hay fields and cornfields.

METHODS

a



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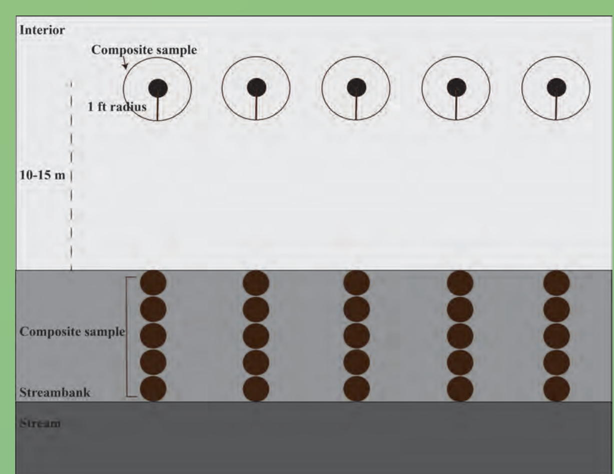

Figure 1. (a) Distribution of sampling sites in the Summer 2015 in the Missisquoi River Watershed. Forested sites are depicted in green, corn fields in yellow, hay fields in red and wetlands in light blue. (b) In each site, 10 soil samples (10-cm deep) were taken, 5 corresponding to the Interior and 5 to the Streambank. Interior samples were taken in a straight transect parallel to the stream, separated from the streambank 10-15 m. Each sample consisted of a composite between a central point and 4 random points located in a 1m radius. Streambank samples consisted of a composite of 5 points along the vertical profile.

- Sampling:
  - Four land uses were studied: Forests, Corn fields, Hay fields and Wetlands
  - 32 sites distributed along the Missisquoi River (northern Vermont, USA) and its tributaries were sampled in the period of June-August 2015 (Fig.1a); 8 sites per corresponding land use. Sampling design is shown in Fig. 1b.
- Particle Size Analysis was determined with hydrometer method.
- Total P was measured with Inductively Coupled Plasma (ICP-OES) after microwave assisted nitric acid digestion (Method 3051a; USEPA 2007).
- Degree of P saturation (DPS) was determined by Courchesne and Turmel's (2007) modification of the acid ammonium oxalate extraction and P (P_{ox}), Iron (Fe_{ox}) and Aluminum (Al_{ox}) were measured with the ICP-OES. DPS was then calculated using the following equation:

$$DPS = P_{ox}/(0.5[Al_{ox}+Fe_{ox}]) \times 100\ \%$$

- Plant-available P was determined with a modified Morgan extraction (pH 4.8 ammonium acetate buffer in a 1:5 ratio, McIntosh 1969) and the Murphy-Riley colorimetric method.

RESULTS

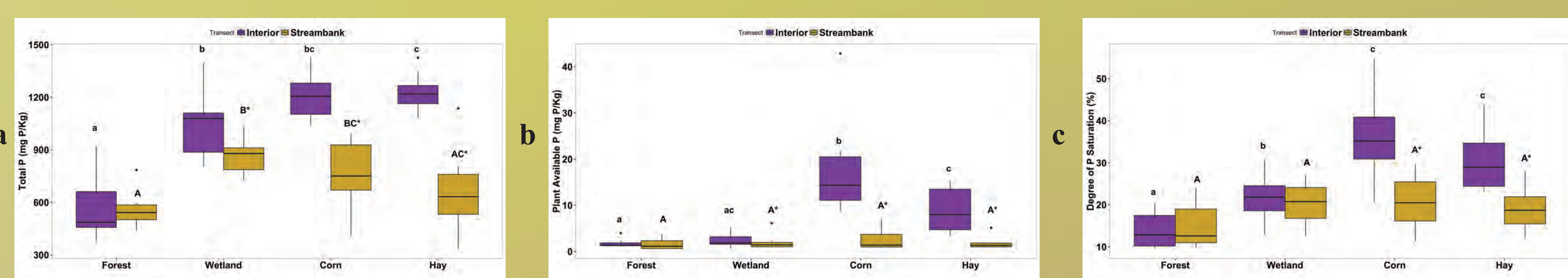

Figure 2. Differences in (a) Total P, (b) Plant Available P, and (c) Degree of P saturation (DPS) between the different land uses studied and between their location in the sites (Interior or Streambank). Statistical significant similarities among different land uses in each location are denoted by the use of the same letters (lowercase and uppercase for Interior and Streambank, respectively), while statistically significant differences between the Interior and Streambank are denoted with an asterisk (p<0.05).

Table 1. Soil characterization by land use.

Land Use	Transect	% N mean	% N sd	% C mean	% C sd	pH mean	pH sd	Organic Matter % mean	Organic Matter % sd	% Sand mean	% Sand sd	% Silt mean	% Silt sd	% Clay mean	% Clay sd
Corn	Interior	0.213	0.063	2.303	0.783	6.69	0.48	3.96	1.35	51.46	14.44	40.23	12.87	8.30	3.52
	Streambank	0.210	0.209	1.731	0.958	6.79	0.42	3.00	1.64	65.64	13.29	27.14	12.24	7.24	2.43
Forest	Interior	0.259	0.183	3.441	1.855	5.54	0.76	5.93	3.23	57.04	13.84	31.76	10.96	11.17	6.06
	Streambank	0.113	0.043	1.600	0.898	6.02	1.08	2.76	1.56	69.73	11.34	20.90	9.62	9.36	4.10
Hay	Interior	0.311	0.092	3.583	1.206	6.33	0.60	6.18	2.08	31.96	10.74	53.89	7.39	14.16	9.79
	Streambank	0.099	0.063	1.226	0.837	6.41	0.45	2.11	1.46	63.34	24.33	26.45	20.10	10.20	8.38
Wetland	Interior	0.464	0.313	6.158	4.054	6.03	0.65	10.60	6.99	31.40	12.55	56.05	9.72	12.55	7.00
	Streambank	0.221	0.115	3.154	1.861	5.96	0.33	5.46	3.21	46.99	19.46	41.97	16.35	10.99	6.77

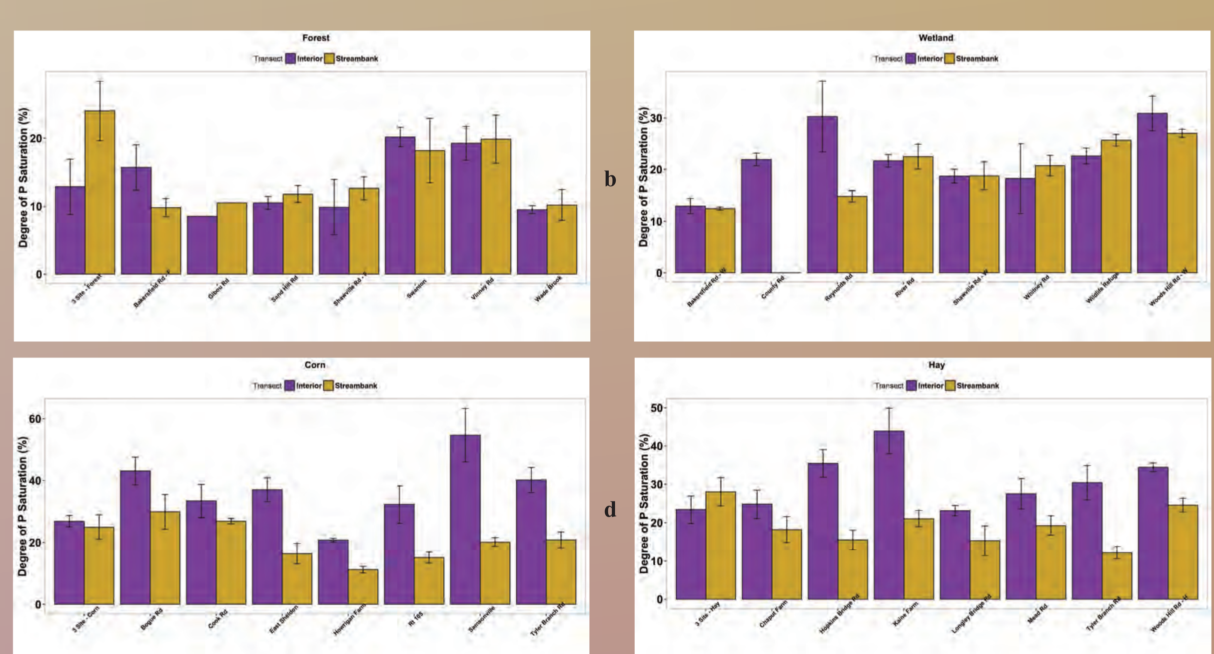

Figure 3. Degree of P Saturation in the Interior or Streambank of each site of the different land uses studied: (a) Forests, (b) Wetlands, (c) Corn and (d) Hay fields. Error bars denote standard deviation.

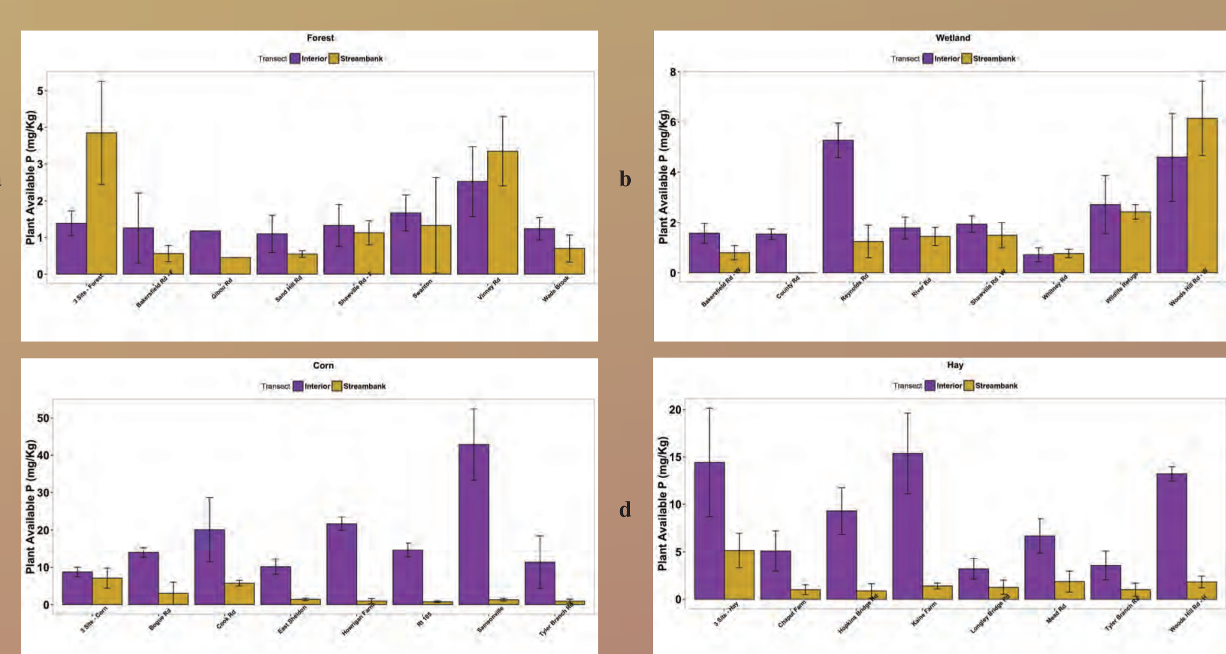

Figure 4. Plant Available P in the Interior or Streambank of each site of the different land uses studied: (a) Forests, (b) Wetlands, (c) Corn and (d) Hay fields. Error bars denote standard deviation.

CONCLUSIONS

- With the exception of forest streambank soils, the total P of the corresponding streambanks of each land use was statistically significantly lower.

- Plant-available phosphorus was very low in forest, wetlands, and all the streambanks of the different land uses; while higher than the optimum plant-available P recommended for soils in Vermont in corn and hay fields.

- The DPS averaged 36% in the corn fields, but was less than 21% in all of the streambanks.

- The combination of low plant-available P and low saturation suggests that the streambank soils will not release significant amount of P if eroded into the adjacent streams.

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