TEMPORAL VARIABILITY OF PHOSPHORUS CONCENTRATION IN THE STREAM TO SQUAM LAKE, NEW HAMPSHIRE DURING STORM EVENTS

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INTRODUCTION

Phosphorus (P) is the primary limiting nutrient, essential for the growth of algae in most freshwater aquatic systems.[1,2] Nutrient loading from streams in the watershed is the major input. However, the effects of storm events on P loading is not well studied. Typically, P input increases with the magnitude of rainfall/runoff events but may exhibit hysteresis.[3] This study addresses changes in P concentration and speciation with precipitation, runoff, and streamflow during 3 storm events in Livermore Cove Brook of Squam Lake.

OBJECTIVES

1. To measure the P concentration in the stream at hourly resolution during storm events
2. To measure the temporal variability of different P species during storm events
3. To explore the contribution of different flow paths to P concentration and species during the event

SITE DESCRIPTION

- Drainage area = 177 ha
- Forested land = 91.7 % with mixed deciduous and evergreen forest
- Wetland = 3.4%
- Pasture land= 2.5 %
- Scrubland = 0.4%

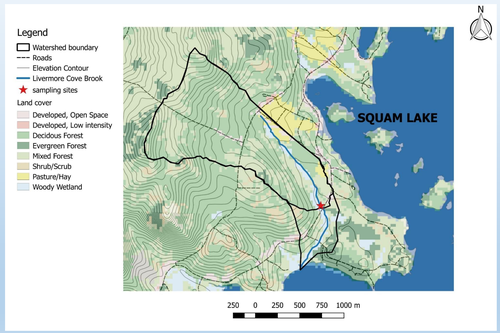

Fig 1: Map of Livermore Cove Brook watershed

METHOD

- Streamwater was collected during three precipitation events during summer 2016 on an hourly basis using ISCO samplers.
- All the samples were analyzed for specific electrical conductivity, turbidity and deuterium isotope (^2H). The ^2H of each sample and rain water were used to calculate the percent of new water (%NW) in the stream.
- Total P (TP) and total dissolved P (TDP) were measured using persulfate digestion method followed by colorimetric determination using ascorbic acid and molybdate blue. Inorganic P as soluble reactive P (SRP) was measured similarly but without persulfate digestion.
- Total particulate P (TPP) was calculated as TP – TDP and dissolved organic P (DOP) was calculated as TDP - SRP.
- Stream discharge ($m^3\ h^{-1}$) was calculated as UD * watershed area.
- TP load was calculated by multiplying the concentration of TP and stream discharge.

RESULTS

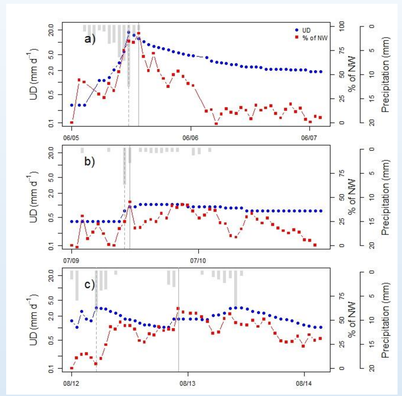

Fig 2: Time series of Unit Discharge (UD) and % of New water (%NW) with hyetograph of a) event one, b) event two and c) event three.

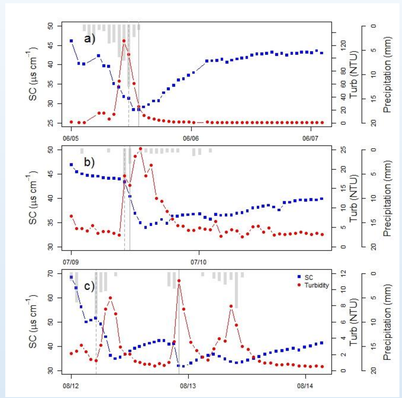

Fig 3: Time series of specific conductivity (SC) and turbidity (Turb) with hyetograph of a) event one, b) event two and c) event three

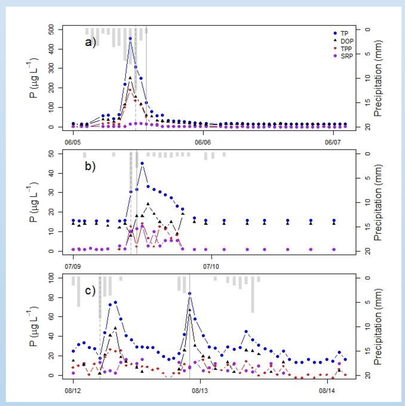

Fig 4: Time series of total phosphorus (TP), dissolved organic phosphorus (DOP), total particulate phosphorus (TPP) and soluble reactive phosphorus (SRP) with hyetograph of a) event one, b) event two and c) event three

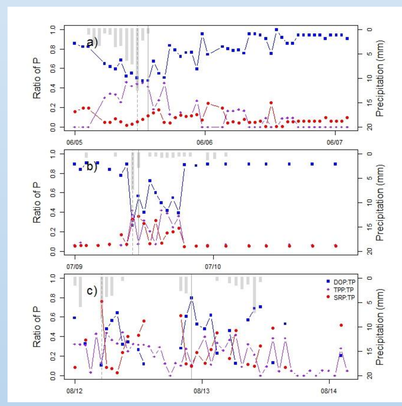

Fig 5: Time series of TPP:TP, DOP:TP and SRP:TP with hyetograph of a) event one, b) event two and c) event three.

The solid lines in the graphs show the maximum %NW and dotted lines show the maximum precipitation.

How much TP yield is made by storm events??

Events	TP yield (kg/ha/event)
One	0.0075
Two	0.0003
Three	0.0012
Total	**0.009**

These 3 events had made 5-10% annual TP yield in just six days.

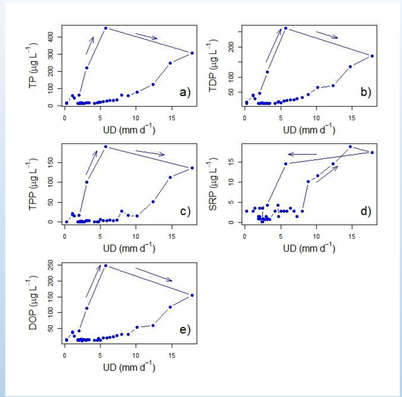

Fig 6: Hysteresis loops between unit discharge (UD) and a) TP, b) TDP, c) TPP, d) SRP and e) DOP for the first event.

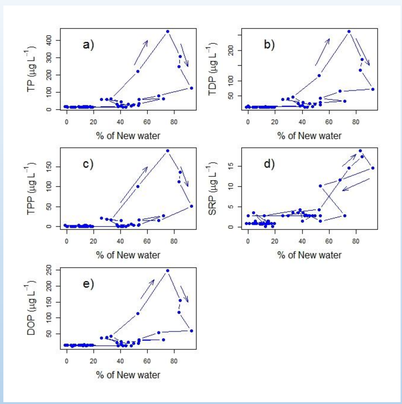

Fig 7: Hysteresis loops between % of new water (%NW) and a) TP, b) TDP, c) TPP, d) SRP and e) DOP for the first event.

CONCLUSIONS

- ❑ Storms generate higher UD, concentration and yield of P in the stream.
- ❑ Dissolve P is more dominant than particulate P and among dissolved P, organic P is more dominant than inorganic P.
- ❑ Storm events contribute a disproportionate amount of P to Livermore Cove Brook load. Our preliminary estimates showed that these 3 precipitation events resulted in 5-10% of annual load occurring in just 6 days.
- ❑ The SRP was minor component during event but was more significant during baseflow periods. SRP also lagged UD, suggesting its more consistent groundwater source.
- ❑ P concentrations on rising limb of hydrograph were much higher than on falling limb which resulted in clockwise hysteresis. SRP had made anticlockwise hysteresis indicating that it was from different source.
- ❑ This study is useful to find the approximate natural P loading in other watersheds of Squam Lake nearby and control the anthropogenic P loading in the stream.

REFERENCES

1. *Wetzel, R. G. 2001. Limnology: Lake and River Ecosystems. Gulf Professional Publishing.*
2. *Mainstone, C. P., and W. Parr. 2002. Phosphorus in rivers — ecology and management. Science of The Total Environment 282–283:25–47.*
3. *Rodríguez-Blanco, M. L., M. M. Taboada-Castro, and M. T. Taboada-Castro. 2013. Phosphorus transport into a stream draining from a mixed land use catchment in Galicia (NW Spain): Significance of runoff events. Journal of Hydrology 481:12–21.*

Fig 8: Setting Isco sampler to catch storm event in Livermore Cove Brook