The effect of Elevation on Phosphorus Levels in Soil and Water in the Winooski, Lake Champlain and Missisquoi River Basins

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Abstract:

After noticing a correlation between soil phosphate levels and the elevation of the stream sites, we looked at the different kinds of phosphorus tested. We measured total phosphorus, which is all of the phosphorus in the solution regardless of its form, as well as available phosphorus, the phosphorus estimated to be available to organisms. In order to analyze a potential trend between phosphorus levels and stream sites' elevations, we graphed the elevations and their averaged available phosphorus levels in soil. This method was also done to compare elevation and the average total phosphorus levels in the soil. Based on the analysis of the data and the graphs produced from the data sets, several conclusions can be drawn. As the elevation increased, the soils' average available phosphate levels decreased, and the soils' average total phosphate levels increased.

Those correlations then led us to see if elevation's impact on the soil's phosphorus levels had an effect on the phosphorus levels in the streams. The data used in our study was taken during July 23, 2012 to August 23, 2012, as this was the time frame that all of the schools collected data. Using data from the water samples collected in the streams, the average phosphorus in the stream was compared to the average available phosphorus from the soil. The average phosphorus in the water samples was also analyzed and compared to the stream sites' elevations. The average phosphate in water increased when the average available phosphate in soil increased. As elevation increased, the average phosphorus in the water decreased.

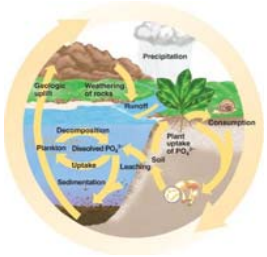
The story of P

Phosphorus as a nutrient

Phosphorus is a required nutrient of many plants. In many cases, phosphorus could be considered a "limiting factor", meaning that it limits the population growth of species in a certain environment. Since it can be a limiting nutrient, it is often used as a fertilizer to remove limits on growth. Using phosphorus as a fertilizer also has its drawbacks. Freshwater ecosystems are limited in their plant growth by amounts of phosphorous. This limitation keeps a balance in the river and helps control certain populations that would otherwise grow exponentially. Adding more phosphorous to aquatic environments through runoff from fertilized areas can cause eutrophication (excessive nutrient input). This leads to excessive growth and domination of certain plant species. In the case of Lake Champlain, it leads to algal blooms.

Sources of Phosphorous

Pure elemental phosphorus is actually extremely rare. Typically phosphorous is found as phosphate ions. (Combination of phosphorus and oxygen.) Unlike many nutrients phosphorus is not found in the atmosphere. The main sources of phosphorus are rocks containing phosphate salts, water and organisms. Since rock is a reservoir of phosphates the data showing phosphate amounts in the soil is very significant. Although water is listed above as a location of phosphates, the cause is mostly erosion and the input of phosphate from soil and rock into water. This explains our correlation between soil phosphorus and total phosphorus in the water. Organisms hold phosphorus because plants absorb what they can from their environment since it is an essential nutrient. Phosphorus is then passed down the food chain and eventually cycled back into the water or stored away in rock.



Summary of Phosphorus tests done

Total phosphorus is all of the phosphorus in the solution regardless of its form.
Available phosphorus is the phosphorus estimated to be available to organisms.
Water quality P is also a total phosphorous measurement meaning that it is a measurement of all the phosphorus in the solution regardless of its form.

Table of all the stream sites used in our data analysis.
(Missisquoi was excluded from our data since it was an outlier from a different site.)

Winooski River Basin		Lake Champlain Basin		Missisquoi River Basin	
School	Site Code	School	Site Code	School	Site Code
Peoples	WR_LtlRiv_696	Colchester	LCD_PndBrk_179	Lake Region	MR_BrgBrnch_813
Stowe	WR_GoldBrk_952	Rice	LCD_PoBrk_133	Missisquoi *	MR_HingfdBrk_281*
VT Commons	WR_HntRv_536				

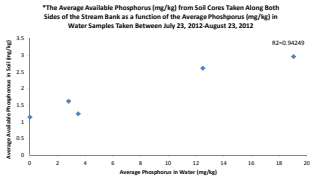
Low Elevation Stream

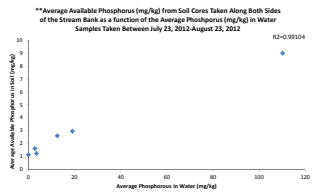
Map of all sites in group B

Correlation coefficients showing the effect of the omission of Hungerford Brook* (Missisquoi River basin) and the Little River** (due to missing water quality data).

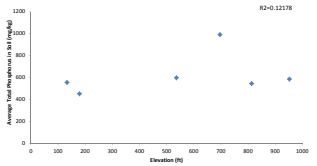
Soil Average P vs. Elevation	0.662	0.331*
Total P vs. Elevation	0.122	0.188*
Phosphorous (water) vs. Elevation	0.649	0.170*
Soil Average P vs. Water P	0.940**	0.99***

*includes MR_HngfdBrk_28
** excludes WR_LtlRiv_696

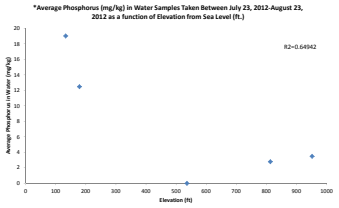


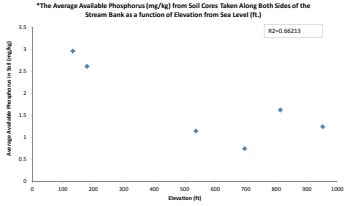


High Elevation Stream



High Elevation Stream





Conclusion:

Our findings suggest that the greater the elevation, the less amount of dissolved phosphorus there is in the stream and soil. We believe that this is because there is less exposure and impact from development and increased erosion due to human activity. The higher the elevation, the less human influence there is on a stream simply due to a lesser density of humans. At lower elevation, there is a higher population density and as a result a greater use of fertilizers and greater impact on the landscape. Low elevation areas have higher nutrient deposition, thus making better farmland and a better chance of nutrient loading due to fertilizers used on these farms. These flatter low elevation lands are also heavily developed with dense human populations. This leads to more fertilizer use in residential lawns and gardens.

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