Analysis of pH Buffer Capacity of Soils in the Macatawa Watershed

Mitchell Gage, Katie VanZytveld, Scott Warner

Buffer Capacity

- A Buffer is a solution that can RESIST changes in pH to a degree when an acid or a base are added to the solution.
- What does this have to do with soil?
  - o The buffering capacity of soils is vital to their biotic and abiotic interactions with the ecosystem

Determining Buffer Capacity

- Soils with higher clay and organic content in their composition have been shown to generally have a greater buffer capacity

- Calcium compounds, most notably Calcium Carbonate($CaCO_3$), are major contributors to the buffer capacity of a soil

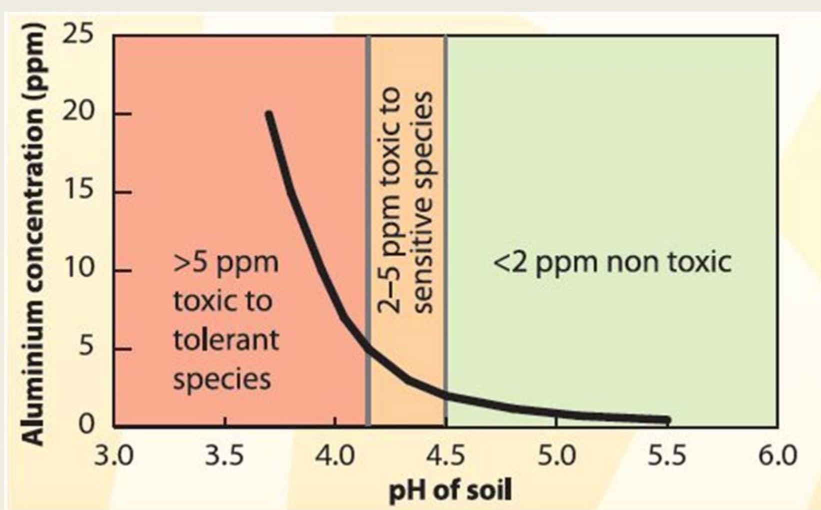
Some Causes of Soil Acidification

1. Acid precipitation from industrial pollution
1. Man-made fertilizers
   a. Many of these Nitrogen-based products oxidize into nitrous and nitric acid
1. Decomposing accumulated organic matter
   a. Releases fulvic and humic acid

Solubility of Toxins

- Lowering the pH of soils leads to increased solubility of toxins
- Particularly Aluminum

Effects of Aluminum



Changes in Microbial life

- The Microbial community structure of a soil is fundamentally related to the pH of the soil.
- Numerous studies have shown that even slight changes in pH can drastically alter the bacteria living within the soil, dislodging bacteria which may have ecological significance for the area they inhabit.

Nutrient Availability

- As soil becomes more acidified the availability of many essential nutrients for plant growth become more limited, including:
  - Nitrogen
  - Phosphorus
  - Sulfur
  - Calcium
  - Magnesium
  - Sodium
  - Molybdenum

Effects on the Watershed

- Increased Aluminum solubility within a soil means more aluminum leached into water
- If soil within a watershed does not effectively buffer acid and it finds its way into bodies of water it can stress or outright kill some aquatic organisms, particularly fish
- The one-two punch of increased acidity and aluminum in a body of water has been shown to be extremely detrimental to water quality

How is it Measured?

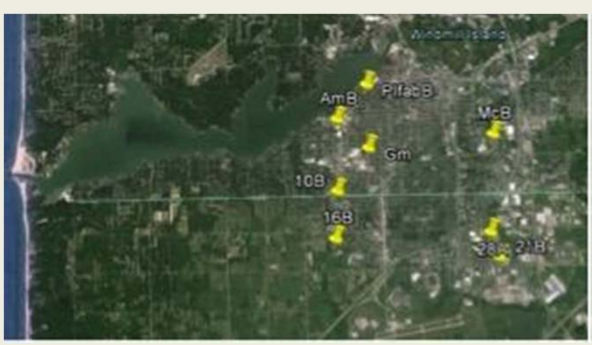
- All of these harmful consequences of soil acidification can be avoided by increasing the buffering capacity of the soil, often referred to as Lime Buffering Capacity (LBC) in this context
  - LBC is defined as the weight of pure lime ($CaCO_3$), in milligrams, required to raise the soil pH of one kilogram of the soil in question by one unit.

Questions

- What are the native LBCs of different soils in the Lake Macatawa watershed?
- Will soil acidification pose an ecological threat in the long term?

Collection of Samples

- ~100 g samples
- From A layer (topsoil)
- 7 different soil series



- Yellow = more acidic
- Blue = more basic

Soils Sampled

10B

Gm

Plfab

28A

16B

AmB

McB

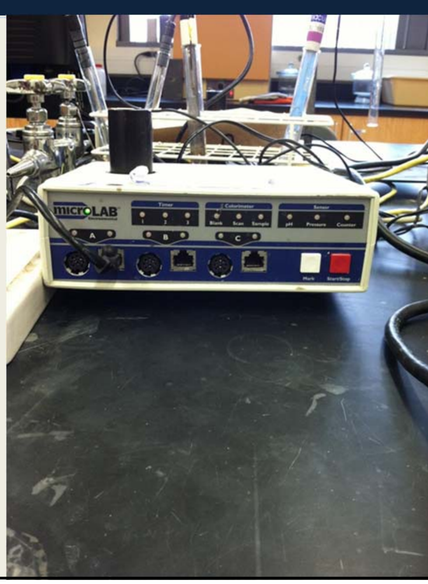
Soils of the Watershed

	Soil Series							
	10B: Oakville Fine Sand	16B: Capac loam	McB: Mancelona loamy sand	Gm: Granby loamy sand	AmB: Au Gres loamy sand	PlfabB: Plainfield sand	28A: Rimer loamy sand	Total Percent of Watershed
Series Percent of Watershed	2.9	4.9	2.2	5.9	2.7	8.0	3.5	30.1
Related Series Percent	4.3	4.9	4.3	5.9	3.0	12.5	3.5	38.4

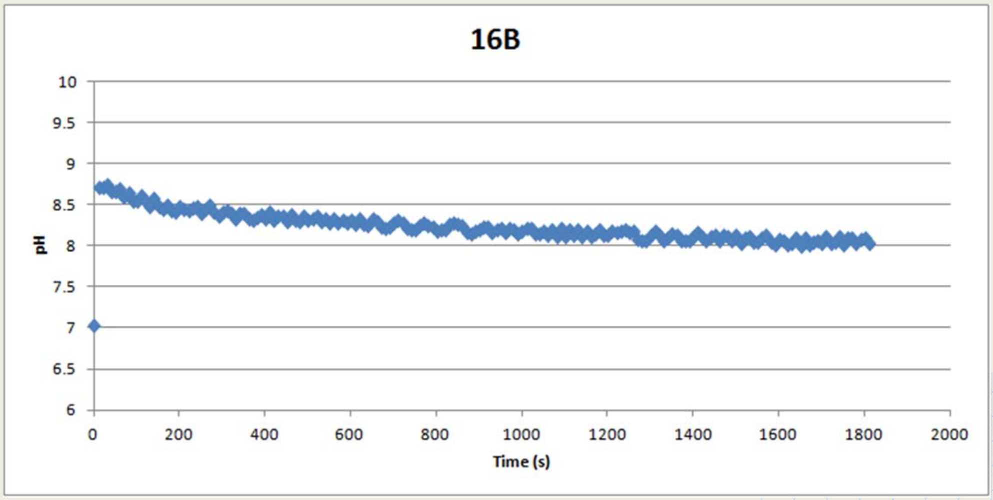
Soil Composition

Soil	16B	McB	Gm	AmB	10B	PlfabB	28A
Approximate sand %	>52%	>75%	>75%	70-91%	~90%	85% or more	>52%
Parent material	Loamy till	Sandy and gravelly outwash(Loamy sand)	Sandy lacustrine deposits	Sandy outwash	Sandy outwash	Sandy glaciolacustrine deposits	Sandy Glaciofluvial deposits over loamy till

MicroLab



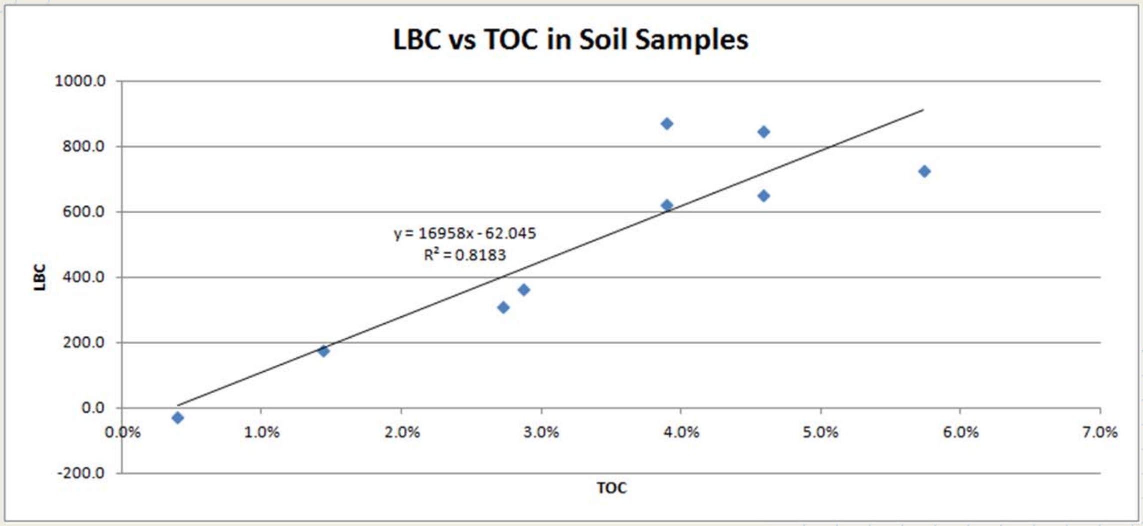
Example Test Graph



Results

	Soil Series						
	16B	**McB**	**Gm**	**AmB**	**10B**	**PlfabB**	**28A**
Buffering Capacity (30 min)	150.3	220.9	136.1	228.8	43.8	251.2	99.6
Buffering Capacity (5 day)	363.6	622.7	311.3	651.5	-27.3	728.4	177.2
% Carbon	2.9%	3.9%	2.7%	4.6%	0.4%	5.7%	1.4%

Results



Conclusions

- The soils of the Lake Macatawa watershed are generally sandy
- The sandy soils have characteristically low pH and low organic content
- Low TOC correlates to poor buffering capacities of local soils
- The pH of Lake Macatawa varies from 7.1 to 9.2
  - o Increase due to aquatic photosynthesis throughout the summer
- Inability to efficiently buffer acidic content could lead to acidification of Lake Macatawa and the surrounding land

Acknowledgements

- We would like to thank Dr. Hansen & Dr. van der Weijden of the Hope College Environmental Science Department, Dr. Shorb & Dr. Wunder of the Chemistry Department
- Cooperating area landowners
- Macatawa Area Coordinating Council