From molecules to climate change: Nitrogen and carbon cycling at the ecosystem scale

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Project description: Interested in studying the ecology of agriculture? Want to help improve our understanding of how little things like nitrogen and carbon affect big things like climate change? Then look no further--we study carbon dioxide (CO_2) emissions and storage from the use of lime (crushed carbonate rock, a form of inorganic carbon), which is used to neutralize soil acidity. It is added in massive quantities to agricultural soils and is an anthropogenic manipulation of the carbon cycle that is not well understood. As global agricultural intensification continues, farmers will use more nitrogen fertilizer, which acidifies the soil, and will use more lime, too. When the lime dissolves in soils it can be a net *source* of CO_2 to the atmosphere or net CO_2 *storage*, depending on the reaction involved. Irrigation using alkaline groundwater typical of Michigan is another addition of inorganic carbon as it delivers carbonate-rich groundwater to agricultural soils.

The use of lime is expected to increase in step with global agricultural intensification, specifically with the increase in nitrogen (N) fertilizer use. N fertilizer (specifically ammonium or urea-based) acidifies soil. Some of this N is taken up by the crop, what is left over is nitrified by soil microbes. Nitrification is where microbes oxidize ammonium (NH_4^+) to nitrate (NO_3^-), and the hydrogen ions released from ammonium increase soil acidity. We are interested in how agricultural management practices like N fertilizer rate and groundwater irrigation affect nitrification because they determine soil acidity, the need for lime inputs, and ultimately the fate of carbon—whether it is emitted to the atmosphere or stored in the soil. We have an on-going field experiment where row crop plots are treated with different levels of N fertilizer and presence/absence of groundwater irrigation. **This summer we will work with a student to develop an independent project involving nitrification rate measurements on surface soils from the field experiment.** We have several different options for approaching this issue. This study is important because of nitrification's relationship with lime-carbon and its product, nitrate, has strong effects on environmental health.

Fellowship details: The student will also participate in collecting and analyzing other samples from the field experiment, helping our lab's other REU's as needed, as well as other research going on in the Hamilton lab. This research-intensive fellowship will take place at KBS from May 23-August 5, 2016 (11 weeks). The student will work on average 40 hours a week. The ideal candidate will be enthusiastic about learning and research, be able to think and work independently, and be open to providing and receiving constructive feedback. We hope to continue working with the student after the summer experience to publish a paper on their findings. We are excited about mentoring an undergraduate student this summer and about this soil nitrogen study. Feel free to email Bonnie at mcgillbo@msu.edu with questions. She can also put you in touch with her 2015 summer undergraduate student who can tell you what it's like to work with us and live at KBS.