Statement of Research Interests and Vision

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My research interests are primarily in soil hydrogeochemistry, a multidisciplinary field with strong links to soil science, hydrology, geochemistry, climate science, and water resources. I plan to continue my research in the area of soil hydrological and biogeochemical processes by collaboration with colleagues in the department as well as international scholars. In the past two years working in the Ecohydrology Research Group, I developed a series of novel techniques in the lab, including an automated soil column system, an automated flow injection switch-box, different pore water sampling devices, and high resolution electrochemistry sensors which I am now using for a series of innovative research projects. The results of these projects will provide a mechanistic understanding of biogeochemical interactions between groundwater and surface water, and also will help the development of quantitative models of hydrogeochemical processes.

Some of the research areas that I am currently working in the framework of Ecohydrology Research Group include:

- ***Effect of water table fluctuations on soil biogeochemistry under redox dynamics.*** The contrasting redox conditions above and below the water table are important, because the pathways, rates and products of many biogeochemical transformations strongly depend on the local redox conditions. The results of one of our soil column experiment revealed that dynamics of transient redox conditions enhanced microbial oxidation of soil organic matter, resulting in a pronounced depletion of organic carbon in the groundwater-surface water interfaces.

- ***Sensitivity of soil carbon degradation to climate change through water-table feedback.*** With coupled physical–biogeochemical soil measurements and models, I study how water table dynamics effect on sensitivity of soil decomposition and loss of soil organic carbon in a changing climate.

- ***Theoretical and experimental studies of solute transport in porous media affected by heterogeneous structure (e.g. dual-porosity)***. Chemical transfer in porous media is affected by the structure and transport properties when preferential liquid movement and complex geometry of the liquid interfaces is occurred due to the physical and chemical heterogeneity. This research will help us to address the issue of solute transport in subsurface as well as the problem of contaminant transport in vadose zone with fractured and complex soil structure.

- ***Biogeochemical and hydrological controls on fate and transport of nutrients at the watershed scale.*** To study the influence of riparian and hyporheic zones on stream hydrology and nutrient biogeochemistry, we are monitoring the spatial distributions of nutrient elements in the riparian and hyphoreic zones at the *rare* Charitable Research Reserve site.

- ***Soil biogeochemistry dynamics under effects of freezing and thawing cycles.*** Future climatic change is likely to alter the frequency and intensity of the thawing of frozen soils which highlights the impact of this short-term phenomenon on soil biogeochemical and microbial activity processes. This project will be conducted in the new low temperature controlled-environment chambers.

- ***Coupling between electrical resistivity and microbial activity in soil.*** In research collaboration with Dr. Estella Atekwana (Department of Geology, Oklahoma University), we are developing a new method for direct measurement of microbial activity in soil by electrical resistivity changes. This project will create a potential for the use of geophysical response to soil microbial activity and soil biodegradation.

- ***Groundwater contribution to fecal and nutrient pollution at the beaches of the Great Lakes.*** In research collaboration with Dr. Clare Robinson (Department of Civil and Environmental Engineering, University of Western Ontario), we are studying fundamental understanding of the contribution of groundwater and the way in which the interacting hydrological, biogeochemical and microbial processes occurring near the sediment-water interface impact fecal and nutrient pollution at beaches of the Great Lakes.