Hydrological and Biogeochemical Resilience of Human-dominated Watersheds

NSERC Discovery Grant; PI: Claire Oswald

Significance: This research will inform sustainable management of urban water resources in Canada.

Mimico Creek beneath Gardiner Expressway

More than 50% of the world's population now lives in urban areas and this is projected to increase to 60% by 2030. Across scales, urbanization is characterized by increases in impervious surface area, reductions in water infiltration rates, and increases in surface runoff. These alterations to the natural landscape drastically alter the timing and magnitude of stream hydrological responses to precipitation inputs. When rain- or melt-water washes over impervious surfaces it collects pollutants and carries them into the stormwater-stream system leading to degraded water quality. To slow water down and prevent excess materials from reaching water bodies, stormwater control measures are often employed. Despite these efforts, the negative impacts of urban development on stream health remain and are now exacerbated by more frequent extreme weather events.

The overall goal of this research program is to advance our understanding of the cumulative impacts of climate and land use changes on the hydrology and biogeochemistry of human-dominated (i.e. urban and urbanizing) watersheds.

Collecting samples at East/West Holland Watershed site

The **short-term objectives of the research** include:

1. Examining the influence of land use patterns on the hydro-biogeochemical behaviour of human-dominated watersheds,
2. Quantifying the impact of stormwater control measures on the hydro-biogeochemical behaviour of human-dominated watersheds, and
3. Assessing and comparing the hydrological and biogeochemical resilience of different human-dominated watersheds to extreme events.

Willow Creek Watershed

These objectives will be addressed through a variety of temporally and spatially intensive hydro-biogeochemical field sampling approaches in four meso-scale watersheds and their sub-catchments located in south-central Ontario. The study watersheds span a gradient of size and land use from highly urbanized to dominantly agricultural. Geospatial determination of effective, or hydraulically connected, impervious area and the quantification of multiple metrics of the spatial distribution of land use will be carried out for each watershed. Catchment hydrological functioning, specifically the proportion of 'new', event water leaving the catchment during storm events and the distribution of water ages leaving each watershed on multiple time scales, will be estimated using stable water isotopes. Catchment biogeochemical functioning will be assessed through the spatial analysis of key water quality data collected seasonally during synoptic longitudinal surveys of multiple headwater catchments (with and without stormwater management ponds) in the study watersheds. Lastly, statistical analyses of precipitation-runoff and solute concentration-discharge relations at the watershed-scale will be used to evaluate the resilience of different land use patterns to extreme weather events.