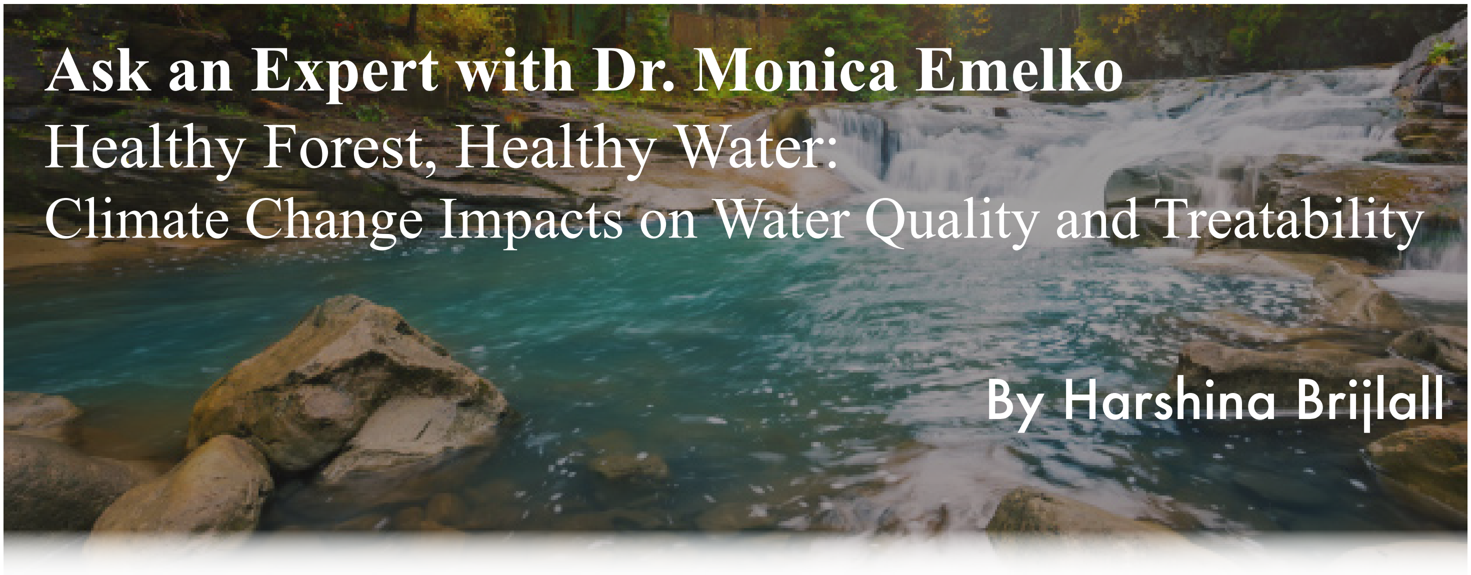

Ask an Expert with Dr. Monica Emelko

Healthy Forest, Healthy Water: Climate Change Impacts on Water Quality and Treatability

By Harshina Brijlall

In 2014, the International Panel on Climate Change (IPCC) concluded that we could not rely solely on available water treatment technologies to supply safe drinking water. The report cited Professor Monica Emelko's work on the impacts of wildfires on water quality and treatability. Emelko's research demonstrated that wildfire-exacerbated fluctuations in and deterioration of source water quality challenges water treatment, sometimes beyond operational response capacity.[1] In an interview with Emelko, she describes key water quality issues and climate change-related disturbances while emphasizing the need to manage landscapes for resilience.

How have forested landscape disturbances impacted drinking water source quality and treatment?

Many people living in Canada would be surprised to find that their water originates in forested landscapes. Forests are critical for the provision of water because they are vital to many hydrological processes such as interception, infiltration, and evapotranspiration. Forests capture water via vegetation and provide natural purification through their complex root systems.[2,3] The water storage and infiltration capacity of forests is tremendous. The value of Canadian forest product exports is estimated to be $33.1 billion.[4] While it is generally understood that anthropogenic disturbances such as development and industrial pollution can affect freshwater supplies, our in-depth understanding of how climate change exacerbated landscape disturbances can have significant impacts on water quality and treatability is more limited.

Disturbances such as fires, heavy storms, and hurricanes are increasingly plaguing Canada and many parts of the world. Historically, the winter season leads to a wet spring, resulting in vegetation growth during subsequent warmer seasons. Processes such as wildfires naturally occur during these warmer periods because they are critical to the evolution of many forests in western Canada. The cones of some tree species will not open to release seeds or germinate without heat. Changing climate has resulted in weather extremes, including wetter springs followed by longer, dryer seasons that are especially vulnerable to compounded disturbances such as pest infestation or wildfires followed by heavy precipitation events. Increase in early snowmelt results in a build-up of vegetation. The long, dry, and hot summers and resulting dry vegetation create a prime environment for fires or extreme storms. The loss of vegetation reduces interception resulting in more precipitation reaching the ground surface and increasing soil erosion,[5] thereby impacting water quality. The many fine sedimentary deposits found in Canada result from historical glacial depositions on the landscape. Once eroded from the landscape, these sediments are stored in riverbeds and move downstream over long distances during high energy and high flow conditions (i.e., when the sheer critical stress for erosion is exceeded).[5] The sediments may release essential contaminants such as dissolved organic carbon (DOC), which leaches from soils and other surficial materials such as bioavailable phosphorus. Although natural aspects of water quality, these contaminants—suspended solids, DOC, and bioavailable phosphorus—are critical drivers of drinking water treatment process design and operation that are often elevated and more variable after severe wildfires.[6] The 2016 wildfire in Fort McMurray demonstrated that these impacts can be detected even at large basin scales when only a small fraction (~5%) of a watershed burns.[7] Fire can have extreme impacts on water supplies and is useful to study because water supply and treatment resilience to wildland fire-associated changes in source water quality are also relevant to other landscape disturbances.[6]

What are the impacts of algae proliferation on drinking water quality?

When people think of water quality deterioration, they think of contamination or pathogens. The pandemic has revealed how critical water is for basic sanitation in personal hygiene. While not optimal, boil water advisories and "do not consume" orders are preferred over water outages because they still allow water to be used for sanitation. Water restrictions or shutdowns occur when water treatment operations are unable to produce enough safe water. The proliferation of algae can result in the production of toxins of health concern.[8] Algae can also cause other problems in treatment by disrupting and clogging treatment processes, therefore, requiring increased chemical treatment.[9] This is partly because algae and other microorganisms can transform dissolved organic carbon.[10] Cyanobacteria can also be linked to taste and odour events that are very unpleasant though not of any health consequences.[8] Notably, elevated concentrations of fine suspended solids can promote the proliferation of cyanobacteria and other algae in drinking water reservoirs because they can release key nutrients such as bioavailable phosphorus to the water column. Conventional water treatment plants in Canada (and globally) are not typically equipped to deal with the treatment challenges—especially toxins and taste and odour compounds—that algae and other cyanobacteria can cause. Ongoing research is focused on strategies for nutrient management in reservoirs to prevent algae proliferation, early signalling of algae proliferation, and improved algae monitoring.

How has climate change impacted processes in water treatment plants?

The difficulty in water treatment plants is not treating more deteriorated water but keeping up with water quality fluctuations.[10] Historically, many treatment plants were designed assuming the water systems to fluctuate within a specific range. Climate change-associated extreme weather now makes water quality challenging to predict. So how do we need to design water treatment plants? We need to think about increasing the resilience of the landscapes where the water originates and the location of water treatment plants. The water industry is increasingly moving to advance on the promises of techno-ecological nature-based solutions (NBS) for water supply and treatment.[6,10] Frameworks describing and integrating these "green" technologies have been developed.[6,10] One example of techno-ecological NBS includes implementing shorter- and longer-term forest management techniques for increasing water supply resilience.[6,10] Holistic approaches improving the resilience of our systems, on both the landscape and in water treatment plants, will enable treatment plants to continue operating such that there are fewer water advisories or service disruptions.

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