Mercury dynamics in thermokarst lakes: Potential risk to Arctic Indigenous Communities and Wildlife

Beatriz Malcata Martins[1,2], Manuel Lopes Soares[1], Holger Hintelmann[3], Martin Pilote[2,4], Rute Cesário[1], João Canário[1,2]

[1]Centro de Química Estrutural, Institute of Molecular Sciences, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal

[2]Center for Northern Studies (CEN), Université Laval, Québec, QC, Canada

[3]Water Quality Centre, Trent University, 1600 West Bank Drive, Peterborough, ON K9J 0G2, Canada

[4]Environment and Climate Change Canada, Aquatic Contaminants Research Division, Montreal, QC, H2Y 2E7, Canada

In Arctic and Subarctic regions, the number of thermokarst lakes is increasing with the onset of climate change. These ecosystems are rich in organic matter and their formation is due to the degradation of permafrost, a type of soil considered a natural barrier to carbon, nutrients, and contaminants such as mercury (Hg). As the permafrost thaws, all that was stored in this reservoir is remobilized into the surrounding ecosystems directly influencing their interactions with microbial communities and biogeochemical cycle. Mercury represents a major threat as it is a toxic pollutant. Of particular concern is the bacterial formation of methylmercury (MMHg), which could be elevated in thermokarst lakes as they may have ideal conditions for the relevant microbial communities. MMHg is a potent neurotoxin that can easily bioaccumulate and biomagnify in food webs, affecting Arctic Indigenous Communities who depend on traditional diets. Monitoring levels and understanding processes involving toxic Hg species is crucial to evaluate this additional risk of permafrost thaw to Arctic ecosystems and human systems.

In this work, the data presented was collected in the Canadian Subarctic near Kangiqsualujjuaq, Nunavik. Two thermokarst lakes (Lake 5 and Lake 11) were sampled in winter and summer of 2023 and sediment and water samples were analyzed for total Hg (THg) and MMHg. In the water column, both lakes showed higher THg concentrations in winter with concentrations in Lake 5 between 12.6-18.4 ng/L and in Lake 11 between 6.8-8.7 ng/L, and an average proportion of 80% MMHg. In the summer, Lake 5 THg concentrations varied between 3.5-12.1 ng/L and Lake 11 decreased to values between 5.0-7.4 ng/L, both with an average of 27% MMHg. In sediments, Lake 5 revealed low variability in Hg concentrations with values of less than 90 ng/g of THg and 2.9 ng/g of MMHg in both seasons. In Lake 11, THg was more than twofold higher in summer (up to 48 ng/g) than in winter (up to 21 ng/g) and showed an average of 1.8% MMHg in both seasons. Results showed high Hg methylation potential in both seasons with the risk of transporting these high levels of MMHg to the other aquatic systems during lake drainage that could have an important impact on the wildlife and Indigenous communities.