BACKGROUNDER: **MeHg and Dams**

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Dangers of MeHg

Mercury is produced through human activity as well as from natural emissions in air, water and soils. It is usually present in the non-toxic inorganic form. However methylating bacterial in aquatic systems can transform the inorganic mercury into the toxic organic form methylmercury (MeHg). The health effect of MeHg is a worldwide concern particularly due the fact that it can have neurotoxic effect on humans and especially on developing babies.[1] In addition MeHg is known to bioaccumulate in aquatic fish and other sea food tissues and therefore poses a threat to humans through bioaccumulation in the food chain.[2] The first instant of MeHg poisoning, known as Minamata disease occurred in Minamata Bay, Kumamoto Prefecture, Japan in the 1950s that led to widespread neurological damage of babies born to mothers than consumed contaminated sea food.[3] Another incident prompting vigorous research on the health effects on MeHg poisoning was its use as a fungicide for seed treatment in Iraq in the early 1970s that resulted in a high rate of brain damage and mental ill-health in children born to mothers that had consumed treated seeds.[4]

MeHg and Dams

Research work done on MeHg in reference to flooding of reservoirs has shown that concentrations in dam reservoirs are generally higher compared to reference lakes.[5] Dams are designed to enable stable flow of water for hydroelectric power generation. There are over 10 hydroelectric generation dams in Newfoundland Labrador. During large dam run-off events, the impoundment can lead to significant geochemical and biological changes in the receiving aquatic system as well as the surrounding terrestrial environment. Several studies have shown that MeHg is formed from inorganic mercury at the sediment-water interface by methylating bacteria. Flood-controlled impoundments such as from a dam could lead to higher levels of MeHg by enhanced methylation of mercury by methylating bacteria. Several factors account for this phenomenon. The liberation of the already present sediment-bound MeHg by the impoundment and the increase in methylation of inorganic mercury due to the increased sediment surface area and particulate matter for methylating bacteria action in the receiving terrestrial environment are well studied and characterized.[5-7]

Studies done on MeHg in flood-control impoundments and natural waters of Northern Minnesota, 1997-1977 showed that inflow concentrations from flooding (0.0710-8.36 ng L^{-1}) are significantly higher than reference lakes (0.0140-1.04 ng L^{-1}) at the same location.[8] Impact studies of reservoir flooding of the Experimental Lakes in Northwestern Ontario demonstrated significant increase in concentration of about 10 to 20 times of both MeHg and greenhouse gases in flooded wetland and concluded that microbial decomposition of dead plants and organic soils accounted for the methylation of mercury in the environment.[9] Similar other studies have also confirmed this phenomenon.[10,11]

Careful studies of the potential negative impacts of the receiving reservoirs and surrounding environment following dam spillage such as increased levels of MeHg and the resultant bioaccumulation in fish and other aquatic biota is therefore an important consideration in the design, location selection and mitigation measures of dam reservoirs.

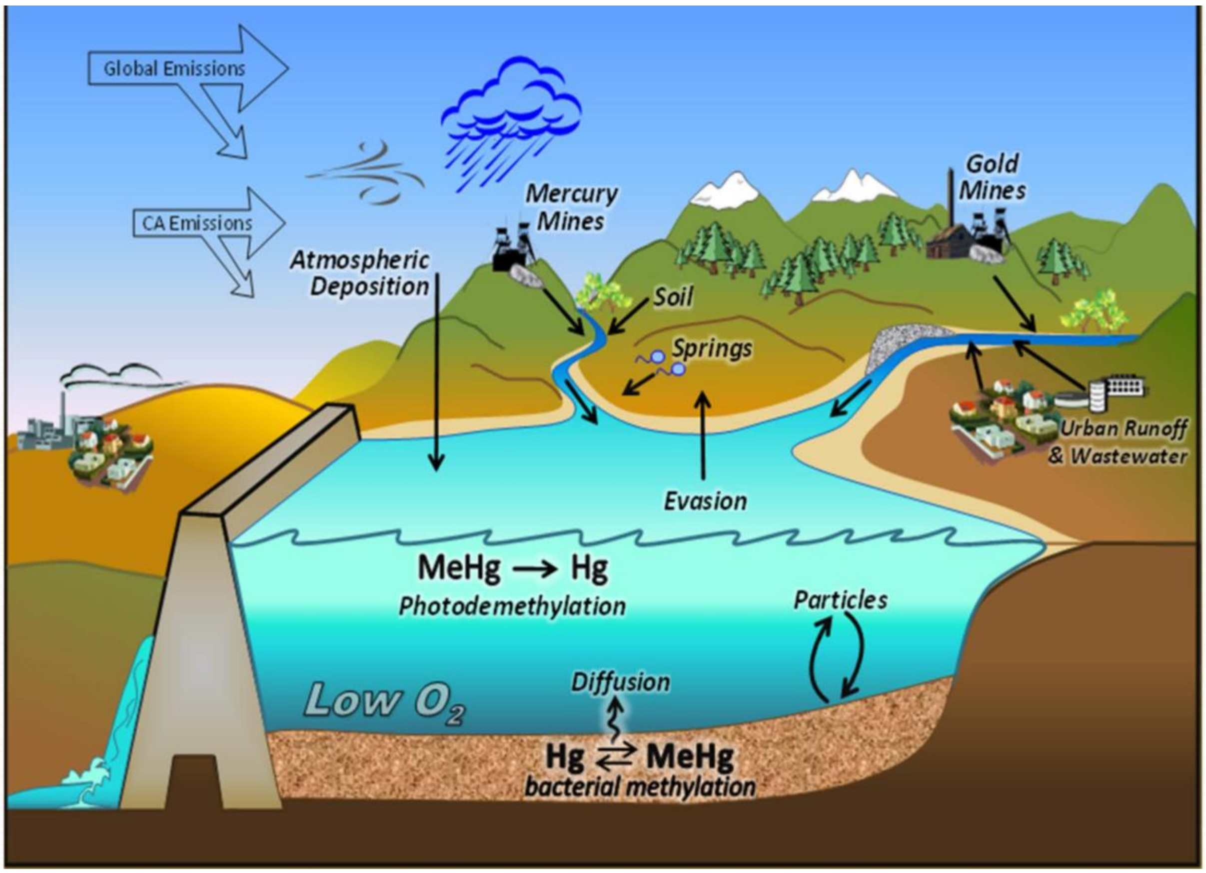

Figure 1: Sources and formation of methylmercury (Source: http://mavensnotebook.com/2013/04/30/mavens-minutes-an-methylmercury-update-from-the-state-water-board/ Retrieved: September 30, 2013)

Mitigation

Mitigation of the negative effects of reservoir flooding reservoirs including increasing levels of MeHg, their bioaccumulation into fauna and flora has been a challenge for industries and governments. Strategies for remediation of the buildup of methylmercury have included pumping of selenium into reservoirs to lower the rate of methylation and bioaccumulation, addition of lime to acidified systems to reduce acidity of reservoirs, and controlled burning before flooding to reduce inorganic Hg present and therefore low conversion to MeHg. These measures have advantages and disadvantages ranging from, on the positive side, no addition of chemicals to reservoir to, on the not so good side, the transportation of meHg and other potentially toxic metals downstream.[13]

Between 1987 and 1996, Recently Hydro-Québec instituted a risk management and mitigation measures for increasing MeHg levels in their hydro reservoirs. The review of potential mitigation measures aimed at reducing the increases of mercury levels in fish of the reservoirs did not provide any realistic solution and thus focus was shifted to reducing the health risks and to provide for remedial measures while allowing people to carry on their traditional hunting and fishing activities and maintaining their way of life. Main measures included providing subsidies for family and community fishing in natural lakes, coastal fisheries of anadromous species (fish that move to fresh water to spawn), wildlife enhancement schemes and schemes to increase harvesting of migratory waterfowl.[14] However, research into mitigating MeHg contaminated ecosystem such as in soils and reservoirs has picked up significantly in the last few years with promising results especially on a small scale although large scale applications are ongoing in some instances. Current research has largely focused on materials than can absorb MeHg, Hg and other toxic contaminants and thereby enhance their removal from the environment. Biochar (specially synthesized charcoal material) obtained from burning biomass such as wood, has been shown to be effective in adsorbing to high extent and reducing the bioavailability and leaching of contaminants such as like polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphecyls (PCBs), mercury and methylmercury in sediments. In a study reported by Ghosh *et al.*[15] in the final report of 'Activated Biochars with Iron for In-Situ Sequestration of Organics, Metals, and Carbon' - SERDP Project ER-2136, they looked at the effectiveness of biochar on the adsorbance of PAHs, PCBs, DDT, mercury and methyl mercury and effect of activation of biochar on the effectiveness of the sorbent. They found that biochar was very effective in removing mercury and MeHg from contaminated soils. Industrial applications of this and other techniques such as the recently patented apparatus for mercury and precious metal recovery by Pegasus Earth Sensing Corp., Alberta, are very promising but are yet to find widespread large scale remediation applications.[16,17]

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