RYAN S.D. CALDER

January 31st, 2018

Ken Reimer, PhD, Chair
Independent Expert Advisory Committee
PO Box 2129. Station B
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Re: Supplementary information regarding data presented in RSD Calder et al. (2016)

Dear Dr. Reimer:

I am enclosing for consideration by the Committee of supplemental information on the relationship between organic carbon and methylmercury (MeHg) content in flooded soils, corresponding to Figure 1 in Calder et al. (2016), further to your request from January 13th, 2018.

Please do not hesitate to contact me if you have any questions or require any clarification.

Sincerely,

Ryan Calder, ScD, MASc

Encl.

References

Calder, R. S. D., A. T. Schartup, M. Li, A. P. Valberg, P. H. Balcom and E. M. Sunderland (2016). "Future Impacts of Hydroelectric Power Development on Methylmercury Exposures of Canadian Indigenous Communities." Environ Sci Technol **50**(23): 13115-22.

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1 Effect of organic carbon content on methylmercury production in flooded soils

Calder et al. (2016) forecasted methylmercury (MeHg) levels in flooded soils as a function of site-wide average organic carbon (OC) content. The linear relationship between post-flooding MeHg and OC was based on a review of journal articles where soil MeHg and OC were measured in artificial reservoirs. Prior work has shown that MeHg production in wetlands may be sulfate-limited and so post-flooding MeHg levels in wetlands is not proportional to carbon content (Harmon et al. 2004; Hall et al. 2005; Jeremiason et al. 2006; Coleman Wasik et al. 2012). Because the future reservoir at Muskrat Falls (and other sites examined in this study) consist largely of unflooded upland soils, wetlands were excluded from this analysis.

1.1 Available data sources

Calder et al. (2016) identified the following articles as data sources:

Hall et al. (2005)

The authors experimentally flooded three upland sites in the Experimental Lakes Area (ELA) of Ontario, Canada and reported post-flooding MeHg stores in the soil (Table 8) and water column. The authors also reported an organic carbon inventory for each of the three sites (Table 1). Study of mature constructed reservoirs has revealed that trees provide negligible labile carbon for methylation of inorganic Hg (Schetagne and Verdon 1999). Therefore, Calder et al. (2016) considered only soil and herb/moss carbon stores, converting values reported in kg OC ha^{-1} to g OC g^{-1} soil using surficial soil density (g cm^{-2}) reported by the authors (para. 2, p. 252). Given the small horizon of organic soils in these sites (≥0 cm per Table 1), Calder et al. (2016) considered both humic and mineral horizons, weighting each according to the reported surficial density. Because only site-wide average quantities were reported by the authors, each of the three sites was reported as a single point on Figure 1 in Calder et al. (2016).

Meng et al. (2016)

The authors sampled four locations across the Wujiangdu reservoir, China. The authors provided raw data for organic matter (OM) and MeHg measurements for a total of 320 points across the four sites. Calder et al. (2016) assumed OC = 0.58 OC, as reported. Figure 1 in Calder et al. (2016) plots site-wide average ± standard error of the mean for MeHg and OC for each of the four sites reported by the authors.

Mucci et al. (1995)

The authors experimentally flooded land adjacent to the La Grande 2 reservoir in Quebec, Canada. The authors provide OC and MeHg measurements for the experimentally flooded soils (Figure 2B). Calder et al. (2016) plotted in Figure 1 the average ± standard error of the mean for MeHg and OC in the experimentally flooded soil.

Rolfhus et al. (2015)

The authors provide supplemental analysis of the relationship between organic carbon and post-flooding soil MeHg in the ELA, Ontario, Canada, nine years post flooding. The authors provided raw data. Calder et al. (2016) plot the average ± standard error of the mean for MeHg and OC in

Figure 1. Moderately lower values than those derived for Hall et al. (2005) may be due to the nine-year lag between flooding and measurement.

1.2 MeHg relationship across sites

Figure 1 in Calder et al. (2016) has the advantage of being applicability over a wide range of soil organic carbon content and synthesizing all available data. It must however be noted that the relationship between post-flooding MeHg and soil OC has been demonstrated on a site-by-site basis by other authors (Hall et al. 2005; Rolfhus et al. 2015). Figure 1.1 below plots MeHg vs. OC data for all sites where this data is available. Linear regression (suppressed intercept) in Figure 1 of Calder et al. (2016) suggests that each additional percent OC in flooded soil is associated with an additional 0.80 ng MeHg g^{-1}. This is within the range suggested by the individual sites synthesized by Figure 1.1 below, where an additional percent OC in flooded soil is associated with between 0.53 and 0.99 ng MeHg g^{-1}. The lower bound, 0.53 ng MeHg g^{-1}, corresponds to data presented by Rolfhus et al. (2015) collected nine years after the most recent flood, and may underestimate the magnitude of the association for recently flooded sites.

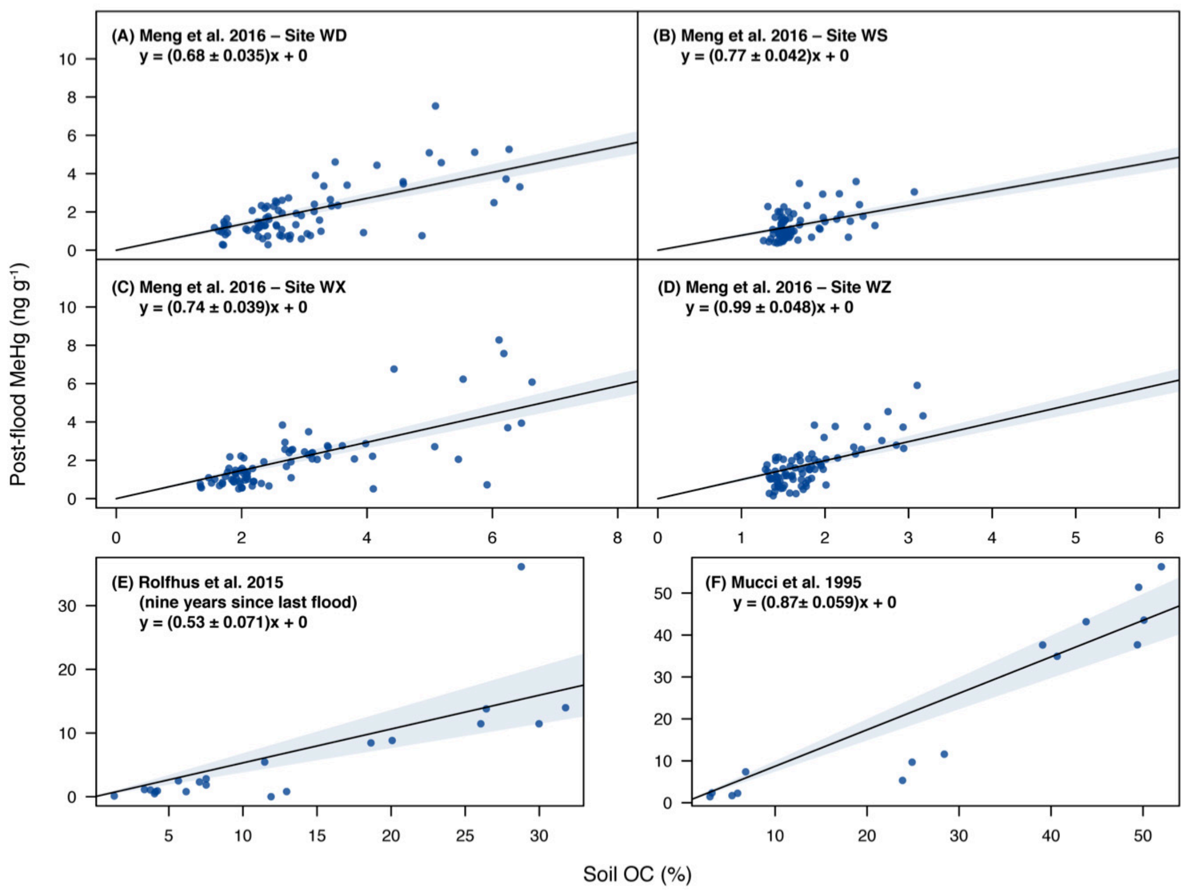

Figure 1.1: Soil MeHg vs. OC across the six sites for which within-site data are available. Linear regression (suppressed intercept) ± 95% confidence interval for regression (shaded area) shown.

1.3 References

Calder, R. S. D., A. T. Schartup, M. Li, A. P. Valberg, P. H. Balcom and E. M. Sunderland (2016). "Future Impacts of Hydroelectric Power Development on Methylmercury Exposures of Canadian Indigenous Communities." Environ Sci Technol **50**(23): 13115-22.

Coleman Wasik, J. K., C. P. Mitchell, D. R. Engstrom, E. B. Swain, B. A. Monson, S. J. Balogh, . . . J. E. Almendinger (2012). "Methylmercury declines in a boreal peatland when experimental sulfate deposition decreases." Environ Sci Technol **46**(12): 6663-71.

Hall, B. D., V. L. St. Louis, K. R. Rolfhus, R. A. Bodaly, K. G. Beaty, M. J. Paterson and K. A. P. Cherewyk (2005). "Impacts of reservoir creation on the biogeochemical cycling of methyl mercury and total mercury in boreal upland forests." Ecosystems **8**(3): 248-66.

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Mucci, A., S. Montgomery, M. Lucotte, Y. Plourde, P. Pichet and H. V. Tra (1995). "Mercury remobilization from flooded soils in a hydroelectric reservoir of northern Quebec, La Grande-2: results of a soil resuspension experiment." Can J Fish Aquat Sci **52**(11): 2507-17.

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Schetagne, R. and R. Verdon (1999). Post-impoundment evolution of fish mercury levels at the La Grande Complex, Québec, Canada (from 1978 to 1996). Mercury in the Biogeochemical Cycle. M. Lucotte, R. Schetagne, N. Thérien, C. Langlois and A. Tremblay (Ed.). New York, NY: Springer Science & Business Media**:** 235-58.