Quantifying Mercury stocks in the Yukon-Kuskokwim Delta

Kelly Turner[1], Jordan Andrew Jimmie[2], Ann McElvein[3], Mia Arvizu[4], Susan Natali[5], Greg Fiske[5], Harald U Biester[6] and Paul James Mann[1]

[1]Northumbria University, United Kingdom, [2]University of Montana, United States, [3]University of California Berkeley, United States, [4]California State University, Bakersfield, United States, [5]Woods Hole Research Center, United States, [6]Technical University of Braunschweig, Germany.

Introduction

Mercury (Hg) inventories from Arctic permafrost landscapes are currently limited, and few contain measurements from fresh waters.

Recent research has highlighted vast stocks of Hg in Alaskan permafrost (Schuster *et al.* 2018) which may be mobilized with future climate change.

Understanding stocks of Hg is important as the reduced form Methyl Hg (MeHg) may enter aquatic food webs posing serious health risks to humans.

This study aims to quantify Hg stores in surface soils, permafrost & waters from the Y-K Delta for the first time.

Method

Soil and water samples were collected over a 2-week period during July 2018. Samples were analysed for total carbon (C) and Hg concentrations.

57 active-layer soil and 15 permafrost core samples were collected from peat plateau's, fens, wet/dry and burned/unburned areas and stored frozen. Samples were dried, ground and milled prior to analysis. Hg analysis was conducted at Braunschweig University, Germany.

58 waterbodies from plateau ponds, ponds in fens, channel fens and small/medium/large lakes were sampled. Waters were filtered in the field (0.45 µm, sterile) before measurement.

Predicted Hg concentrations across the Y-K watershed (Fig.1) were calculated by applying published soil organic carbon (OC) to total Hg ratios (Schuster *et al,* 2018). Soil OC carbon maps were derived using GIS based model and training points.

Freshwater DOC concentrations across a high-res. area (Fig.2) were estimated using relationships between water body size and DOC concentration (Fig.3).

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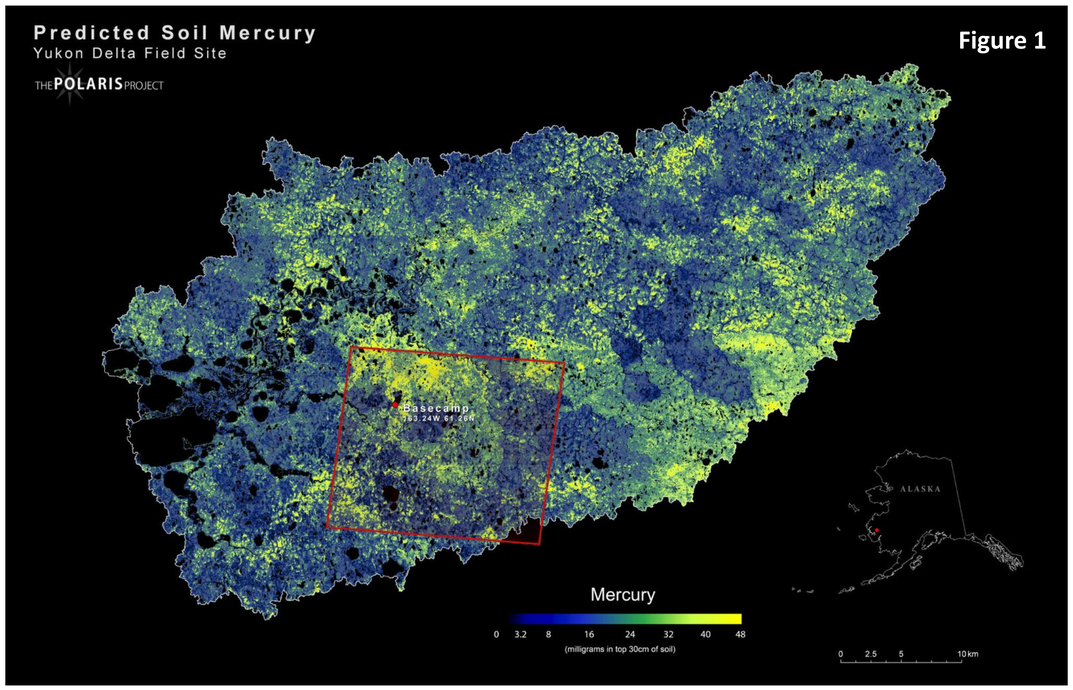

Fig 1. Predicted soil mercury concentration in Yukon-Kuskokwim watershed.

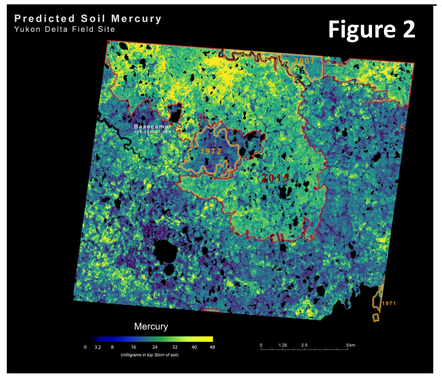

Fig 2. Predicted soil mercury concentrations in the high-res. study area.

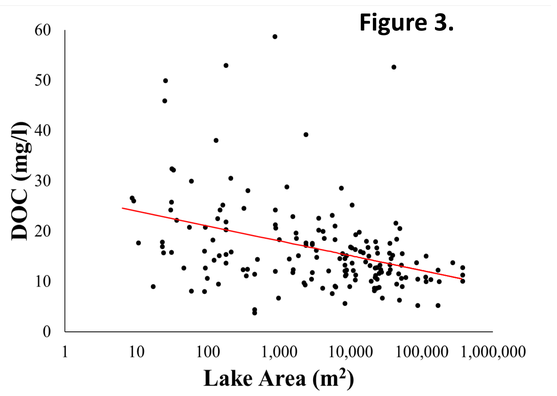

Fig 3. Relationship identified between freshwater DOC concentrations and lake surface area.

Table 1. Average DOC and Hg concentration and stocks in waterbodies of differing sizes within the high-resolution study area (Fig 2).

Lake Area (km^2)	Av. DOC conc. (mg/L)	Av. DOC per lake (kg)	Av. Hg conc. (ng/L)	Av. Hg per lake (µg)	Total Hg stock (g) (Fig 2 extent).
4 (0.01 - 8.2)	19.6	80	1.32	949	3.79
20 (8.2 - 31.6)	14.5	290	1.03	16178	5.58
57 (31.6 - 83.1)	13.1	749	0.95	46700	3.55
128 (83.1 - 173.8)	12.0	1537	0.89	101599	2.24
270 (173.8 - 365.7)	11.0	2972	0.83	212243	0.85
>365.7	10.5	3855	0.80	691335	1.38

Results

Hg measurements from soil samples are pending. If C:Hg ratios prove similar to published soil OC to total Hg ratios (Schuster *et al,* 2018), then upper surface delta soils (30cm) may contain high Hg stocks (> 40mg).

The watershed is estimated to contain 29.5 kg of Hg within the upper 30cm of soil (Fig. 1). 4.39 kg Hg were estimated to be contained within the study area alone (Fig.2). Assuming the upper Hg concentration in the watershed (48mg Hg/ 30 cm depth) and 500g soil suggests 0.096 mg Hg/ g soil.

26 waters contained Hg concentrations below the detection limit (< 0.12ng/L). The remaining 32 samples ranged between 0.12-3.5 ng/L Hg. A significant relationship was found between waterbody DOC concentration and these measured total Hg concentrations ($R^2 = 0.32$, $p < 0.01$).

Using this relationship and Fig 3, waterbodies within the study area (Fig. 2) were estimated to contain 17.39g Hg (Table 1). Smaller lakes with higher DOC concentrations contained higher average Hg concentrations, but due to their prevalence in the landscape total Hg stocks were highest (5.58 g Hg) in smaller lakes spanning ca. 8-32 km^2 in area.

Discussion

Hg stores in the delta may be high. Upper Hg concentrations are estimated to be 96 ng Hg g soil as compared to a median value of 43 ± 30 ng Hg g soil estimated across Alaska (Schuster *et al* 2018).

Water bodies in the study area are estimated to contain 1 to 690 mg Hg dependent upon size.

Delta regions may contain particularly high Hg stocks.

Further Research

- Develop regional DOC to Hg relationships in terrestrial and aquatic environments.
- Assess if Hg species and mobilization within the watershed alters C:Hg ratio.

REFERENCE: Schuster, P. F *et al* (2018). Permafrost stores a globally significant amount of mercury. *Geophys. Res. Lett*45(3), 1463-1471.