Topographical and Hydrological Influences on the Spatial Distribution of Mercury at the Catchment Scale

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Introduction

Significance

•Hg is introduced to aquatic environments predominantly through mobilization of deposited species from nearby terrestrial sources. Therefore, understanding the complex intermediate Hg cycling in vegetation and soils is crucial to predicting its presence in water bodies and potential introduction into food chains.

Previous Studies

•Atmospheric Hg typically occurs in three forms: Hg(0), Hg(II), and Hg(p) or particulate. Hg(0) is the dominant form, comprising 95% of the atmosphere. This form is well-dispersed and can travel tens of thousands of kilometers. Hg(II) and Hg(p), on the other hand, tend to be deposited as few as ten kilometers from the source.

•**Foliage** is a net sink for atmospheric Hg. Studies have revealed that almost all of the Hg in foliar tissue originates from the dry deposition of atmospheric Hg(0) species. The amount of Hg found in litterfall varies as a function of the age and type of the leaves.

•**Soils** can store up to 90% of the Hg in forests. The Hg found in soils is predominantly complexed with organic matter. Sources of Hg to soils include litterfall, direct dry deposition as well as leaching of adsorbed Hg(II) and Hg(p) from leaf surfaces by throughfall.

•*There is little information, however, regarding and the role of hydrology, topography, and prevailing wind conditions on Hg distributions. This study attempts to shed some light on these processes.*

Hypotheses

•Prevailing wind conditions from the coal-fired power plant region of the US result in higher Hg deposition in the NW-facing catchment than the SE-facing catchment

•Regions near the streams are more prone to saturation/mobilization, thus relatively lower concentrations of Hg will be found near the base of both catchments.

Methods

Study Layout

•We chose two paired catchments of disparate aspects from Shenandoah National Park: NW-facing North Fork Dry Run (NFDR) and SE-facing Hannah Run (Figure 1).

•Both NFDR and Hannah Run catchments are roughly 2km^2 in area, have a mean elevation of approximately 800m, and a mean slope of 23˚ They also have similar latitude, vegetation, and underlying geology.

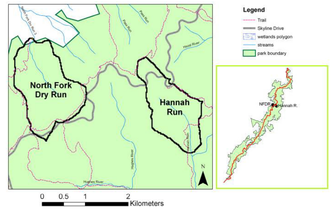

Figure 1: NFDR and HR locations in SNP, VA.

Field collection

•Within each catchment, 15 sites were chosen randomly such that a third of the sites fall within a defined topographic index class.

•Litterfall basins were deployed weeks prior to the peak litterfall period in the SNP (Figure 2).

•On the weekend of November 22, 2008, teams were deployed to collect triplicates of leaves and soils using the EPA's clean hands/dirty hands protocol.

•A total of 88 soil samples and 92 leaf samples were collected, double bagged, and frozen until analysis.

Figure 2: Litterfall basins deployed in SNP.

Lab Analysis

•Soil samples were sieved and digested in nitric acid prior to analysis using CVAFS.

•Leaf samples were frozen in liquid N and ground prior to acid digestion and subsequent CVAFS analysis.

•Additional analysis such as pH and %C/%N content were undertaken.

Results

•Average [Hg] in soils is significantly higher in the NW-facing catchment than the SE-facing catchment.

•Average [Hg] in leaves is not statistically different in the two catchments.

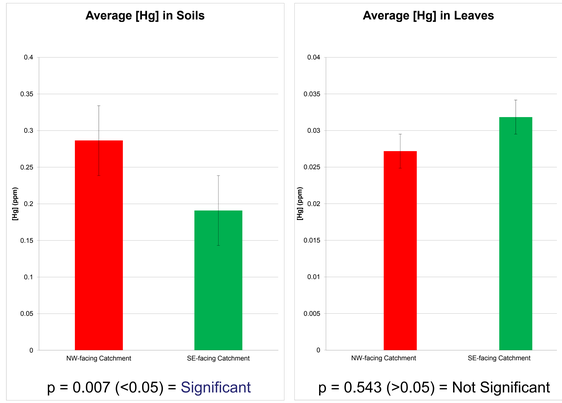

Figure 3: Concentration of Mercury in the Soil and Leaf Samples Collected in the SNP.

•Soil [Hg] is significantly correlated with TI & elevation and samples' %C and %N content.

Both Catchments

Soils - Both	[Hg]	Topographic Index	pH	%C	%N	Elevation
[Hg]						
Topographic Index	**-0.473**					
pH	-0.187	-0.214				
%C	**0.778**	**-0.405**	0.118			
%N	**0.827**	**-0.411**	0.032	**0.925**		
Elevation	**0.396**	**-0.544**	-0.045	0.257	0.200	

NFDR

Soils - NFDR	[Hg]	Topographic Index	pH	%C	%N	Elevation
[Hg]						
Topographic Index	-0.505					
pH	0.000	-0.421				
%C	**0.705**	-0.391	0.173			
%N	**0.728**	-0.489	0.354	**0.925**		
Elevation	0.473	**-0.565**	-0.110	0.235	0.130	

Hannah Run

Soils - HR	[Hg]	Topographic Index	pH	%C	%N	Elevation
[Hg]						
Topographic Index	-0.481					
pH	-0.202	-0.105				
%C	**0.771**	-0.400	0.245			
%N	**0.834**	-0.381	0.095	**0.961**		
Elevation	0.418	**-0.528**	-0.095	0.221	0.184	

Table 1: Correlation coefficient matrices detailing linear relationships between the various factors evaluated in this study. Note: the significant correlations in bold.

•Leaf [Hg] is not significantly correlated with any of the measured variables.

Discussion

•The dominance of coal-fired power plants in the region increases the significance of Hg(II) and Hg(p) deposition rates in the study area.

•The well-dispersed nature of atmospheric Hg(0) could explain the lack of a significant difference between the two catchments' leaf [Hg].

•Soil [Hg] differences probably reflect variations in Hg inputs by throughfall and direct deposition to soil surfaces. Since the predominant wind conditions are from the west, the NW-facing catchment is more likely to scavenge atmospheric Hg(II) and Hg(p), enhancing throughfall inputs.

•There is a statistically significant relationship between areas with higher topographic index and lower concentrations of Hg.

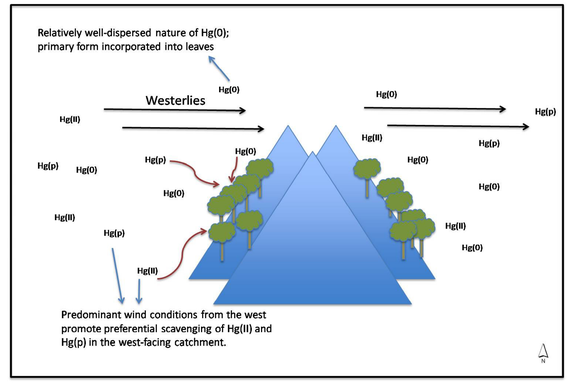

Figure 4: Schematic of possible processes occurring at study sites.

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