

Characterizing spatiotemporal variability in airborne heavy metal concentration: Changes after 18 Years in Baltimore, MD

Joyce J.Y. Lin¹, Mina W. Tehrani¹, Rui Chen¹, Christopher D. Heaney¹, Ana M. Rule¹; ¹ Johns Hopkins Bloomberg School of Public Health, Baltimore MD

Introduction Baltimore is a populous port city along the mid-Atlantic transport corridor with a rich industrial history. Until the early 2000s, shipping and manufacturing dominated the harbor and contributed a considerable proportion of local particulate matter (PM) emissions. However, there have since been tremendous changes to the city's urban and industrial profile. This study investigates the impact of changes in local industry, urban development, and proximity to suspected emission sources on airborne metal concentration in Baltimore, Maryland between 2001 and 2019 with particular focus on the urban industrial community of Curtis Bay in South Baltimore.

Methods Integrated PM_{2.5} and PM₁₀ Harvard Impactors were set up at six locations in the Baltimore City metropolitan area in weeklong sampling sessions to assess variation in airborne metal concentration by proximity to suspected metal emission sources. The samplers were cycled through 5 experimental sites and 1 reference site from January -- July 2019. PM_{2.5} and PM₁₀ were collected on Teflo filters and analyzed for a panel of 12 metals and metalloids (As, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Sb, and Zn) using Inductively Coupled Plasma Mass Spectrometry. The findings were compared against airborne metal concentrations reported by the Baltimore Supersite in 2001 and 2003 to assess changes over the 18-year period.

Results/Discussion PM_{2.5} concentrations reported from this study ranged from 3.27 µg/m³ to 36.0 µg/m³ and PM₁₀ concentrations ranged from 9.00 µg/m³ to 30.1 µg/m³ across all sampling sites. Metal concentrations ranged from 1.4 times (Cd) to 4.8 times (Cr) higher in PM₁₀ compared to PM_{2.5}. Compared to the study reference site, median PM_{2.5} concentrations of Co and Fe were roughly 1.8 times and 2.1 times higher at near-road sampling sites indicating significant variability in airborne metal concentration by proximity to local traffic emissions. PM_{2.5} and PM₁₀ Sb concentrations were 3.4 times and 6.7 times higher at a near incinerator site compared to the reference, consistent with existing evidence of Sb sourcing from municipal incinerators in Baltimore City. Decreases in Cr (-40%), Ni (-73%), Pb (-55%), and Zn (-36%) concentrations were observed over the 18-year period while concentrations of Cu, Fe, and Mn were not statistically significantly different.

Conclusions Declines in airborne Cr, Ni, Pb, and Zn concentration since 2001 appear to coincide with industrial decline highlighting the success of remediation and redevelopment efforts. Remaining spatial variability is related to vehicular traffic and proximity to a municipal incinerator which should be focal areas for future intervention to reduce metal exposure disparities in Baltimore City. Findings about the changes in airborne metal distribution can inform planning decisions in other urban industrial cities undergoing redevelopment.