令和元年度　環境科学院　修士論文内容の要旨

Assessment of heavy metal levels in children's hair at the dumpsite in Lilongwe, Malawi
（マラウイ・リロングウェ市のゴミ廃棄場での児童毛髪中の重金属含有量調査）

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Waste dumpsites are among the significant sources of environmental pollution in developing countries like Malawi. However, limited information exists on the environmental exposure to heavy metals at waste dumpsites and the subsequent health effects. Hair and blood are commonly used to assess exposure to heavy metals in biomonitoring studies. In this study, hair analysis was performed to examine the concentrations of heavy metals in children living close to the waste dumpsite in Lilongwe. We also determined the levels of heavy metals in soil and water to identify the probable exposure pathways at the site.

A total of 188 hair samples was collected from children aged 5–9 years from 8 villages located on the upwind side of the dumpsite in September 2018, and additional information about the participants was obtained using questionnaires. Hair samples were washed with acetone, triton, distilled water, and then digested by acids in a microwave digestion system. Sampling of soil (n = 133) and water (n = 20) was conducted in June 2019. The soil samples were separated into fine sand–silt and clay (< 2 μm) fractions by sieving and sedimentation methods.The concentrations of heavy metals (Mn, Cu, Zn, Cr, Pb, Cd, Sb, Ni) in water and sample solutions were measured by ICP-MS, following the extraction of the soil fractions by aqua regia. The reference materials for human hair were used to validate the methods, and the results were consistent with the certified values.

The results showed that the heavy metal concentrations in the hair of children who visit the dumpsite were significantly higher ($p<0.05$) compared to those who do not visit, except Zn. The Sb, Cr, Mn levels in this study were significantly higher than the normal values of unexposed children in other countries. The concentrations of all heavy metals in dumpsite soils were substantially higher than the soils from residential areas. All heavy metal concentrations in all water samples, well, river and tap waters, in the areas were much below the WHO permissible limits. Comparisons of chemical composition between the two soil fractions indicate Cr, Sb and Zn were enriched in coarser fractions, comparing with Mn, while Ni, Cu, Pb, Cd were accumulated in the clay particles, suggesting that dermal contact, intentional/unintentional ingestion of the soil and inhalation of the dust at the dump site are the probable exposure pathways of each element into the children. This is the first study by hair analysis to demonstrate the heavy metal exposure of children at the dumpsite. Further studies are required to diagnose the health problems by the issue. Also, awareness campaigns on the potential health risks, safety and hygiene should be conducted in the study area.