ABSTRACT

This thesis is based on a field study conducted in the northern part of Vietnam at two rural sites as well as in the capital Hanoi. In Vietnam, pollution problems caused by coal combustion for energy production have been subject to criticism and worldwide attention. To investigate the pollution situation, fine particle samples ($PM_{2.5}$) as well as rain, surface water and biological samples were collected. Cyclones with Teflon filters as collection substrates were used for the collection of the fine particle samples. The elemental analysis of the particle samples as well as of surface and rainwater samples was carried out using an energy dispersive X-ray fluorescence (EDXRF) spectrometer. Total reflection X-ray spectrometry (TXRF) and graphite-furnace atomic absorption spectroscopy (GF-AAS) were used for the analysis of the biological samples.

A comparison of the fine particle composition at the two rural sites showed that all elemental concentrations were 60 – 80 % higher at the site situated in the neighborhood of a coal combustion power plant. Fine particle samples collected in Hanoi revealed concentration levels of the same order of magnitude as in Beijing for some of the investigated elements. This classified the air of the Vietnamese capital as severely polluted. The relatively high concentration of trace metals in the fine particle samples from the rural sites indicates that long distance transport from the heavily industrialized areas in the southern part of China may have contributed to the rural particle load in Vietnam. The high load of fine particles possibly forms a part of the Asian haze or "Asian Brown Cloud" (ABC), a brownish layer of tropospheric pollutants. A comparison of the fine particle composition in Hanoi and Nairobi indicated that the differing sources of energy production in both countries strongly affected the composition of fine particulate matter.

In contrast to the particle samples, elemental concentrations in surface water and aquatic biota were low, reflecting an uncontaminated aquatic biosphere. Significant differences in tissue concentrations between the sampling sites were often confined to one species or tissue type. Elemental concentrations in rainwater combined with deposition estimates indicated that atmospheric deposition of trace metals might have contributed to some extent to the significantly higher concentrations in tissue samples from An Thin, the site exposed to the emissions of the power plant. A comparison of concentration levels in different tissue types showed that biological indicators for environmental pollution must be used with care and based on the knowledge of uptake pathways. A more extensive air measurement campaign would be required to improve the comprehension of the pollution situation in Vietnam and to elucidate the discrepancy between the extent of trace metal pollution in air and aquatic biota.

Key words: Energy Dispersive X-ray Flourescence (EDXRF), Total Reflection X-Ray Fluorescence (TXRF), Graphite-Furnace Atomic Absorption Spectroscopy (GF-AAS), trace elements, Vietnam, fine particles ($PM_{2.5}$), biological indicators, freshwater fish *(C. fucus),* freshwater mussel *(C. bialata* and *P. swinhoei)*