



Spatial sampling of heavy metals along the Chunga River, Lusaka, Zambia.

Bruce D. Malamud (1), Evaristo M. Kapungwe (2), John Volk (3), Jennifer A. Holden (1), Karen S. Harpp (4) and Benson H. Chishala (3)

(1) Department of Geography, King's College London, UK (bruce.malamud@kcl.ac.uk, jennifer.holden@kcl.ac.uk), (2) Department of Geography, University of Zambia, Lusaka, Zambia (ekapungwe2004@yahoo.com), (3) Department of Soil Sciences, University of Zambia, Lusaka, Zambia (jvolk2004@yahoo.com, bhchishala@yahoo.com), (4) Department of Geology, Colgate University, Department of Geology, Colgate University, Hamilton, New York, USA (kharpp@mail.colgate.edu)

We present results of spatial water sampling of heavy metal concentrations along 10 km of the Chunga River in Lusaka, the capital of Zambia. Water from the Chunga River is used extensively to irrigate urban agriculture plots along the river. There are two main sources of pollutants: [**Source I, km 0**] Wastewater (or rainwater flowing over the ground that is contaminated) coming directly from one part of the Lusaka industrial estates areas (about a dozen industrial units); [**Source II, km 3.0**] Wastewater from the whole Lusaka light- and heavy-industrial estates area (>50 industrial units) is treated at the Chunga Sewage Plant for biological pathogens (but not heavy metals), which then discharges the treated water into the Chunga River up to three times a day, acting as a point pollutant source. The first source is 'direct' wastewater, and the second source (with a larger set of industries) passes through the sewage plant.

In August 2006 we took four samples of Chunga River water in the first 3.0 km (i.e. between Sources I and II), and four samples between km 3.0 and 10.0 (ending at Kabangwe). These were subsequently examined for concentrations of Al, Cr, Mn, Fe, Ni, Cu, Zn, Ba, Hg, Pb, U. As a result of these two 'point' sources, one can see very clear trends represented in the amounts of heavy-metals in the river (both ascending and descending). For example, chromium (Cr) has concentrations <1.2 ppb for the

first 3.0 km, and then at Source II (the sewage plant), increases to 150 ppm (above Zambian legislated limits), and then slowly decreases further downstream. Another example is manganese (Mn), which starts off very high at km 0.0 (2,300 ppb, twice Zambian legislative limits) and then decreases relatively quickly in the river to 1000 ppb (km 0.2) and 90 ppb (km 2.3 and 2.8), increasing slightly when encountering Source II (the sewage plant) with 200 ppb. Other examples of the impact of the two different 'point' sources can be seen (e.g. for Al, Ba, Fe, Zn). We find a clear source-pollutant impact in terms of both Source I, 'direct' wastewater (at km 0.0), and Source II (at km 3.0) of industry wastewaters passing through a sewage plant and into the Chunga River. We also find some concentrations of heavy metals in water are well above those that are legislated for wastewater effluent by Zambian law, in addition to levels internationally advised for irrigation use.