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Investigation of the Influence of Heavy Metals on Soil, Groundwater, Crops and Human Health in Shijiazhuang Sewage Irrigation Area of China

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The sewage irrigation area in Shijiazhuang is around 11,000 ha. Based on multi-target sampling strategy, three sections were chosen from upstream, midstream and downstream of the sewage irrigation area. Soil samples totaling 1 kg were obtained at 20 cm intervals over a 2m-depth soil column. A total of 35 soil columns were sampled with horizontal distance of 500m between each other, starting at the sewage irrigation canal and extending to the water irrigation area and the number of soil samples was 339 in all. Additionally, 38 wheat seed samples and 39 corn grain samples were collected from the corresponding surface soil position, and then 25 shallow groundwater samples and 2 surface water samples were collected. Afterwards, heavy metal elements of Hg, As, Cr, Pb, Cu, Zn, Cd were analyzed for all soil samples, crop samples and water samples, and NO-3-N, NO-2-N, COD and volatile phenol were determined for water samples. Using a cluster sampling the cause of death of the permanent residents was analyzed for 95,870 people in the sewage irrigation area and 175,331 people in water irrigation area for the years 2002 to 2006.

The results indicated that the content of each heavy metal element in soil samples from the sewage irrigation area was higher than that in the water irrigation area, but was lower than that of the secondary standard limit of Environmental Quality Standard for Soils (GB15618-95), in which the content of Cu, Ni, As, Hg and Pb all met the first-rate standard. In the sewage irrigation area, the content of Cd in 4 wheat seed samples and the content of As in 1 wheat seed sample of all the crop samples exceeded the standard limit; while there were no samples exceeding the standard in the water irrigation area. In addition, the content of NO-3-N, NO-2-N, COD and volatile phenol in shallow groundwater all exceeded the drinking water standard in the sewage irrigation area, and the content of As, Cr, Pb, Cu, Zn and Cd was higher in the sewage irrigation area than that in the water irrigation area. Moreover, the population cause of death survey revealed that the total standardized mortality ratio in the sewage irrigation area was 526 per 100,000, which was significantly higher than 453 per 100,000 of the water irrigation area (p<0.01); and the cancer-related standardized mortality ratio in the sewage irrigation area was 160 per 100,000, which was significantly higher than 118 per 100,000 of the water irrigation area (p<0.01).

Comparing to the results of previous report for the same research area (Zhao, 1985), the total standardized mortality ratio declined significantly both in the sewage irrigation area and in the water irrigation area. However, the cancer-related standardized mortality ratio increased slightly in the sewage irrigation area, but decreased significantly in the water irrigation area. In our opinion, the overall decline of the total standardized mortality ratio and the cancer-related standardized mortality ratio in water irrigation area are very likely the result of improvements in living standard and medical care of the local residents. Additionally, crop heavy metal pollution, mainly referring to Cd in wheat seeds, and shallow groundwater pollution are considered to be the main reasons for the rising cancer-related standardized mortality ratio in the sewage irrigation area.

References:

[1] Zhao Z (1985) Environmental Science Trends 7: 4-6