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Heavy Metal Pollution of the Semenyih River

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Abstract

A study was conducted on the heavy metal concentrations along the Semenyih River under different landuses. Four areas were selected to represent different landuse namely: forests, settlements and industry, agriculture and mixed farming (crop and animal production). Water samples from a total of 11 stations were collected and analysed for heavy metals. Statistical analysis of the data show that the differences in heavy metal concentrations in the Semenyih River under different landuse are significant except for the forest areas.

Pencemaran Logam Berat di Sungai Semenyih

Abstrak

Satu kajian telah dijalankan terhadap kepekatan logam berat sepanjang Sungai Semenyih dengan pelbagai gunatanah. Empat kawasan telah dipilih untuk mewakili gunatanah berbeza iaitu; hutan, kawasan petempatan dan industri, pertanian dan pertanian campuran (tanaman dan haiwan ternakan). Sampel air daripada 11 stesen telah dikumpulkan dan dianalisa untuk logam berat. Analisis statistik data menunjukkan terdapat perbezaan ketara kepekatan logam berat di Sungai Semenyih dengan jenis gunatanah kecuali di kawasan hutan.

INTRODUCTION

Heavy metals such as arsenic, mercury, cadmium, lead and copper are among the toxic contaminants frequently found in natural waters. The effects of the heavy metals in the environment are due to their persistence since they cannot be degraded once released. Enzyme systems in human and animal metabolism rely on the presence of essential trace elements such as cobalt, copper, manganese and zinc in the diet, and on the relative absence of toxic non-essential elements such as antimony, arsenic, beryllium, cadmium, lead, mercury and thallium (Purves, 1977). Heavy metal contaminants are widely understood and have been studied from different aspects e.g. their uses and pollution levels (Van Borg and Greenwood, 1991; Ohnesorge and Wilhem, 1991; Moore and Ramamoorthy, 1984; Schrauzer, 1991; Mailman, 1980; Scheinberg, 1991). Alloway (1997) has elaborated on the sources of heavy metal pollution such as domestic effluents, industrial effluents, mills, agriculture, forest and farms. Other sources of heavy metals are from leaching processes of ore/rocks by rain or running water or from geologic weathering (Wittmann, 1979; Siegert *et al.*,1986 cited by Ohnesorge and Wilhem, 1991) or from natural recycling through animals and plants (Mailman, 1980). Another source of heavy metals is from pesticides and fertilisers, which are widely used in the agriculture areas and farms of the study area.

GEOLOGY

The Semenyih Basin comprises at least four kinds of rock associations, namely: metamorphic rocks which consists of bedded quartzite and hornfels belonging to the Jelebu Schist (in the northern section of the study area), Semenyih and Broga granites in the central section, another metamorphic rock i.e. the Kajang Formation and rocks from the Kenny Hill Formation (in the southern section), and alluvium deposits along the foothills and river banks of the study area (Figure 1). The Jelebu Schist was proposed by Shu (1989). The age of this formation, based on fossils described by Jones (1973) is Silurian or older. The age of the Kenny Hill Formation, based on ammonoid and crinoid fossils, is Late Paleozoic (Abdullah Sani, 1985) or before the emplacement of the Main Range Granite (Yin, 1989). The granite bodies were emplaced during the Late Triassic.

MATERIALS AND METHODS

Heavy metal analyses was carried out at the Malaysian Institute for Nuclear Technology Research (MINT) using the ICP-AES (Inductively Couple Plasma-Emission Spectrometry Technique). The concentration of each

element was measured at mg/l or parts per billion. The metals analysed in this study are mercury, cadmium, zinc, copper, nickel, iron, and manganese. For rock and soil samples, XRF analysis was carried out at the Geology Department of Universiti Kebangsaan Malaysia using the Electronic Phillips PW 1480 X-ray Digital Spectrometer; the concentration of each element was measured in parts per million (ppm). Only certain trace elements were identified such as zinc, cobalt, nickel, lead, copper, and iron.

Figure 2 shows the distribution of the eleven sampling stations in the Semenyih River Basin, which were selected based on the category of landuse in order to evaluate the impact of landuse on heavy metals concentrations at each station. The pattern and trend of the heavy metal concentrations are shown in Figure 3 and Figure 4.

RESULTS

Mercury concentration in the Semenyih River is very low (average <0.1 mg/l) and the source of this element has become obscured either due to contamination or from soil weathering.

Zinc concentration in the Semenyih River range between 26.7 to 70.1 mg/l (Fig. 4). The highest level was recorded at St.2. Zinc concentration from the XRF study ranged between 14 to 147 ppm. Soils from the Semenyih Granite series contained 147 ppm to 111 ppm Zn, while for metamorphic soils, Zn levels ranged between 47 to 90 ppm. The quartzitic rock contained Zn levels of 4 to 22 ppm.

Cadmium distribution in the Semenyih River ranged from 0.15 to 0.98 mg/l (Fig.3). The highest level was recorded at St.2. The cadmium concentrations are slightly higher at St.3 and St.5 (0.77 mg/l and 0.60 mg/l, respectively). Stations 3 and 5 are located in granitic soil but the landuse at these stations are mainly oil palm plantations and industrial areas, respectively. The normal cadmium concentration in rivers range between 0.05 to 0.8 mg/l.

The cobalt concentration in the Semenyih River range from 0.13 mg/l at St.3 to 1.17 mg/l at St.10 (Fig. 3). Station 10 is an agricultural area with some farms and palm oil plantation related activities. The second highest cobalt concentration was obtained from St.7 (0.87 mg/l), which is close to an oil mill waste water discharge. The XRF analysis of rocks and soils revealed that, the cobalt concentration ranged from 3 to 42 ppm.

Nickel concentrations at eleven stations in the Semenyih River ranged from 1.01 to 7.10 mg/l. The highest at St.7 (7.10 mg/l) was obtained near an oil mill waste discharge point (Figure 3). The nickel concentration from XRF analysis ranged from 4 to 48 ppm; highest nickel was obtained from metamorphic rock.

Lead distribution in the Semenyih River ranged from 0.91 to 12 mg/l. (Fig. 3). Higher lead levels were recorded at St.4 and St.5. Station 4 is located close to a tin mine (PbS ore/Lead sulphite) while St. 5 is close to an industrial area. The lead concentration from XRF analysis ranged from 11 to 90 ppm; the highest was obtained from granitic soil.

Copper distribution in the Semenyih River ranged from 5.96 to 21.2 mg/l. (Fig. 3). The Copper content was higher at St.1 (14.3 mg/l) and St.2 (18.8 mg/l) and this is probably due to leaching from ore/rocks, from oil waste at St.7 (10.1 mg/l), or from farms and other agricultural activities at St.8 (12.3 mg/l). The XRF analysis showed that the copper concentration ranged from 20 to 90 ppm and the highest was from hornfel soils.

The iron concentrations in the Semenyih River ranged from 188 to 1,029 mg/l (Fig. 4). The highest iron content was obtained at St.8, Broga Road, which is close to an abandoned landfill site. The Iron in the form of haematite (Fe_2O_3) is the major element, and ranges from 0.75 to 8.69 ppm in the rocks and soils.

The manganese distribution in the Semenyih River range from 8.93 to 492 mg/l (Fig. 4). The highest manganese concentration was obtained at St.9 which reflects the municipal waste/food industry, and the second highest (365 mg/l) is at St.7.

DISCUSSION AND CONCLUSION

Varying levels heavy metals contamination was discerned in the Semenyih River. The sources of the heavy metals include human activities and natural landuse. The variety of sources of heavy metal concentrations along the Semenyih River can be classified as follows:

Origin from the Source Rock (St.2)

Heavy metal elements such as cadmium, zinc and copper were found at significant levels at St.2 i.e. the Sg. Tekala Recreation Centre. This area covers a granitic body. The weathering of soil in this area has resulted in the presence of zirconium, cadmium and thorium at concentrations between 236 to 370 ppm.

Metalliferous Mining (St.4)

Cassiterite ore mining (SnO_2) was evident in some places in the Lalang River. The pollution discharge at St.4 was indicated by higher suspended and dissolved solids and acidic water. The discharge at St.4 show contamination by lead and iron at significant levels.

Waste Disposal (St.8 and St.9)

Municipal waste waters and solid waste from the Semenyih Town area (St. 8 and 9) contained high levels of iron and manganese. The highest iron content in the study area was obtained at St.8 (Broga Road) and manganese related to the food processing industry at St.9.

Agricultural Areas (St.3, St.8 and St.10)

The use of fertilisers and pesticides in the agricultural areas is something that is inevitable. Lead, arsenic and

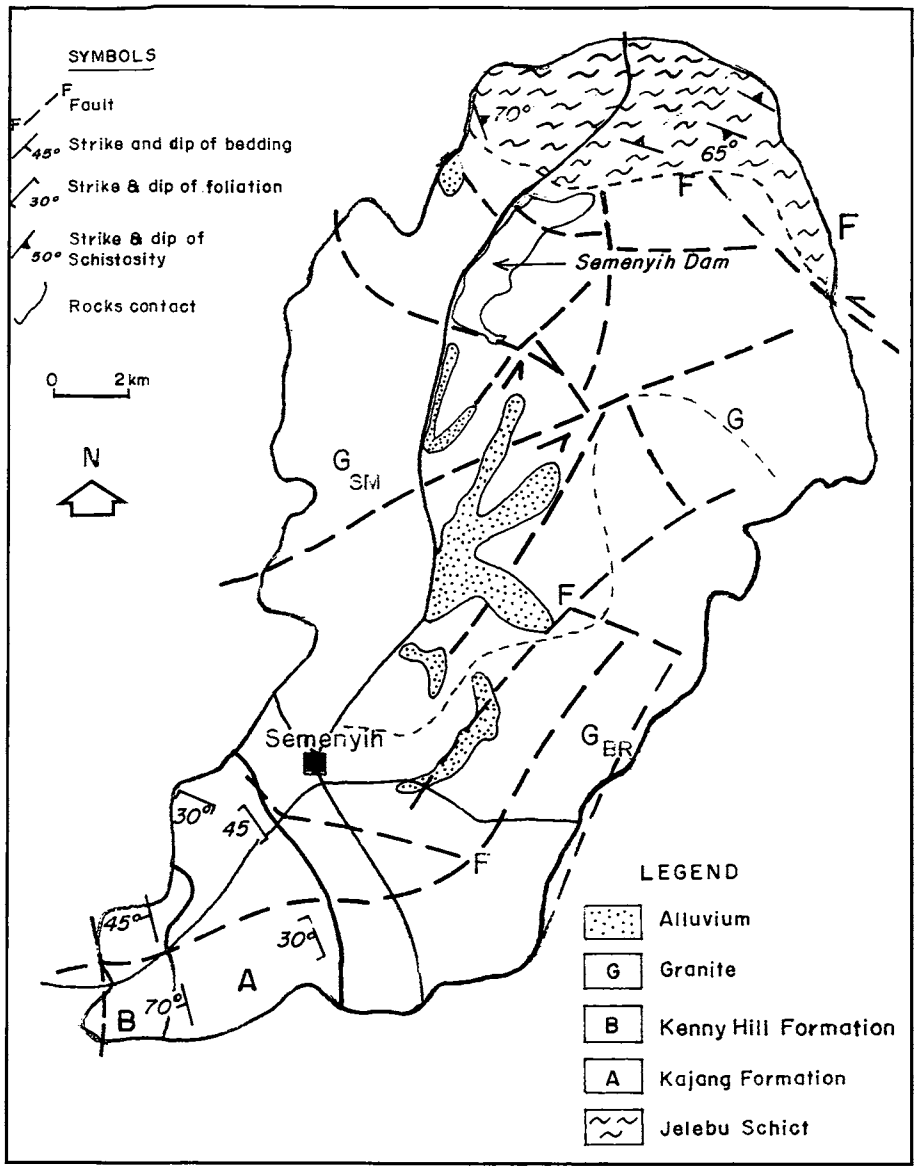

Figure 1: Geological map of the Semenyih River Basin (After Shu, 1989 and Yin, 1989).

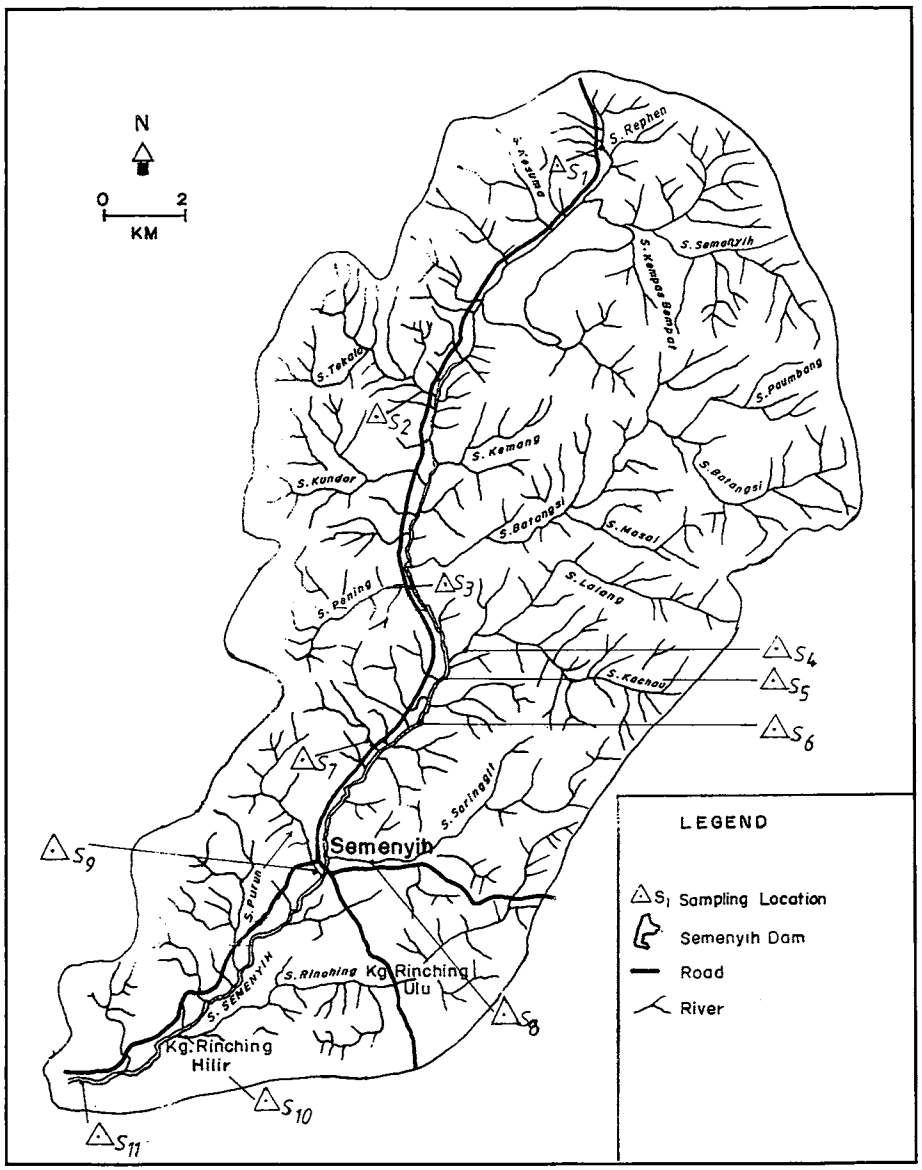

Figure 2: Location of water sampling stations of the Semenyih River Basin.

copper are used as plant fungicides and insecticides, while copper as well as cobalt are used as additives in the swine and poultry feed industry to promote growth.

Oil Mill Industries (St.7 and St.10)

Effluents from St.7 and St.10 indicated a higher content of iron, manganese and copper that are associated with the discharges from the oil mill in the area.

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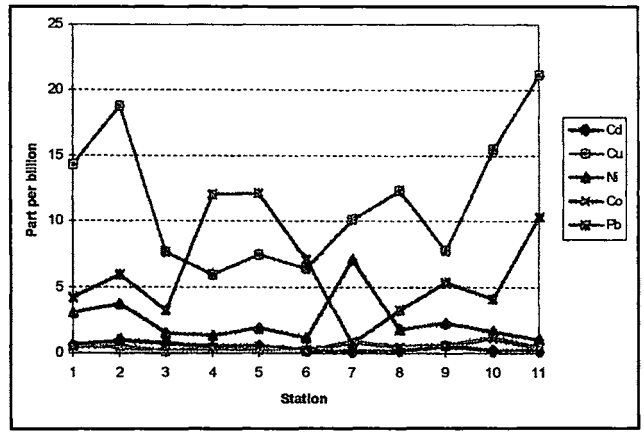

Figure 3: Cd, Co, Ni, Cu and Pb concentrations in the Semenyih River.

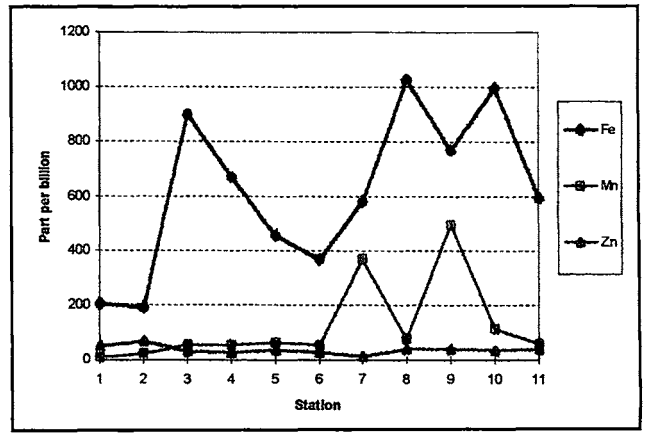

Figure 4: Fe, Mn and Zn concentrations in the Semenyih River.