

Distribution of Heavy Metals Found in Three Major Rivers of North-Eastern Pulau Langkawi

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ABSTRACT A preliminary study on the distribution of dissolved heavy metals such as Cu, Cd, Fe, Pb and Zn in seawater were carried out along the three major rivers of Air Hangat, Kilim and Kisap located in north-eastern *Pulau Langkawi*. Samples were collected from a total of nine selected stations located along these rivers where salinity ranges from 32-36 ppt. Almost all elements showed little variation in concentration along the stretches of the rivers to the open sea. This indicates that their distributions in the coastal area are not regulated by dilution with open seawater. The concentrations of Cu, Cd, Fe, Pb and Zn showed negative correlations with salinity. The low level detection for the metals Cu, Fe, Pb and Zn except for Cd, most probably indicates that it is of a naturally occurring source.

ABSTRAK Satu kajian awal mengenai taburan logam berat terlarut seperti Cu, Cd, Fe, Pb dan Zn di air laut telah dijalankan di sepanjang tiga sungai utama, iaitu Sungai Air Hangat, Sungai Kilim dan Sungai Kisap di timur-utara Pulau Langkawi. Sampel-sampel telah dikumpul daripada sembilan stesen terpilih di sepanjang sungai-sungai tersebut di mana kemasinan berjangka daripada 32 hingga 36 ppt. Kepekatan bagi majoriti unsur tidak menunjukkan perbezaan yang besar menyusuri sungai ke muara. Selain itu, kepekatan Cu, Cd, Fe, Pb dan Zn tidak mempunyai hubungan dengan kemasinan air. Ini menunjukkan bahawa taburan unsur-unsur di kawasan pantai ini tidak dipengaruhi oleh pencairan air laut. Takat pengesanan logam yang rendah untuk Cu, Fe, Pb and Zn kecuali Cd, ini kemungkinan besar menandakan bahawa kehadiran unsur-unsur ini adalah satu kejadian semula jadi.

(heavy metals, north-eastern *Pulau Langkawi*, salinity)

INTRODUCTION

The north-eastern part of Pulau Langkawi is mainly made up of secondary forest which consists of natural vegetation. The three major rivers of Air Hangat, Kilim and Kisap which meanders through this region are mainly infringed with mangrove forests. The Sg. Kisap and Sg. Kilim are connected *via* the Sg. Belanga Pecah channel. Thronged with limestone caves and outcrops, some submerged during high tide, and others only accessible during highest tide.

In this region are found rubber plantations, padi and vegetable farms. The rubber smallholders are quite scattered but the larger plantations are distributed mainly towards the Sg. Kisap area. Towards the interior, there is a municipal landfill site located at the side of Sg. Kisap. Further inland, there are kilns for charcoal production and part of the mangrove land has been reclaimed to make way for an average size housing estate.

Other anthropological contributions to the environment are river transport mainly for tourism and fishing activities. There are also some fish farms mainly cage culture located along these rivers. Since not much study concerning the distribution of dissolved heavy metals in these rivers has been documented and in view of the potential importance of the mangroves to various aspect of the environment, a preliminary investigation was justified.

MATERIALS AND METHOD

Sampling Locations and Method

Samples were collected by grab method from a total of nine stations (1-9) located along the three rivers as shown in Figure 1. All the samples collected were analysed for levels of dissolved heavy metals such as Cu, Cd, Fe, Pb and Zn.

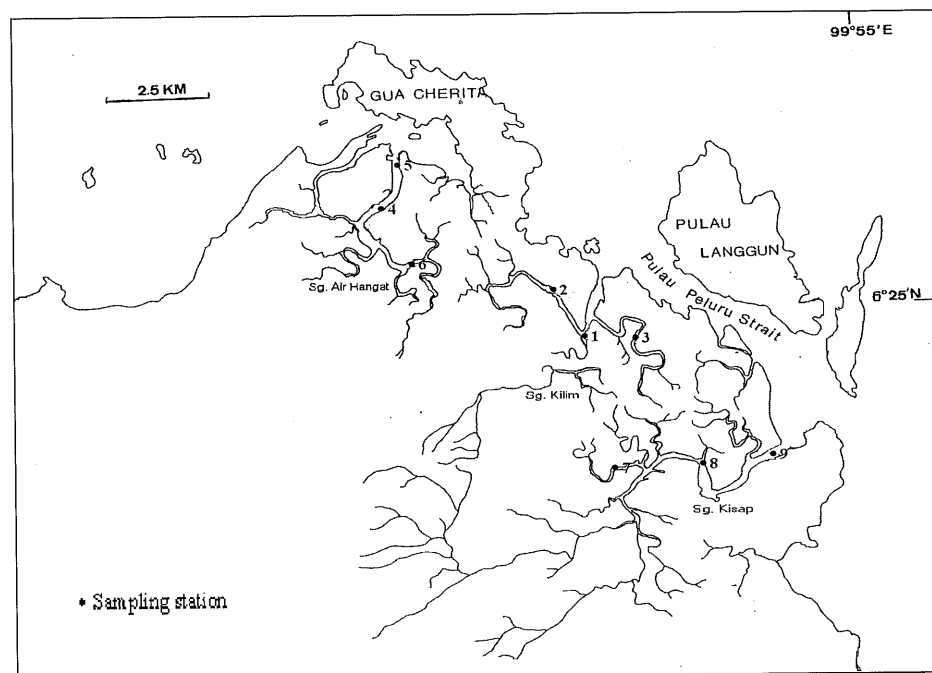


Figure 1. Map of North-Eastern Pulau Langkawi labelled with a total of nine stations (1-9) located along the three major rivers of Air Hangat, Kilim and Kisap.

MATERIALS AND METHOD

Apparatus

A GBC flame atomic absorption spectrometer was employed in the analysis. Atomic absorption measurements were carried out using air/acetylene flame. The operating parameters for working elements were set as recommended by the manufacturer.

Sample analyses

The samples were analysed for heavy metals according to the methodology set by U.S. EPA method 1669 [1, 2]. 200 ml of a well mixed water sample was transferred to a Griffin beaker and 3 ml of concentrated nitric acid was added. The mixture was then slowly evaporated to dryness to avoid boiling. To the cooled mixture was added with another 3 ml portion of concentrated nitric acid and then covered with a watch glass. A gentle reflux action was applied on the mixture. Portions of concentrated nitric acid were added until the digestion was completed, indicated by a light coloured residue. Sufficient hydrochloric acid was added and the beaker was heated until the residue was dissolved. The sample was then filtered and transferred to a volumetric flask

using deionised water. Samples were analysed using a GBC atomic absorption spectrometer.

RESULTS AND DISCUSSION

The concentration of dissolved heavy metals such as Cu, Cd, Fe, Pb and Zn found in the samples were tabulated as in Table 1. The level indicated for each type of heavy element except for Cd, was below the permissible level for river system set by the Department of Environment [3].

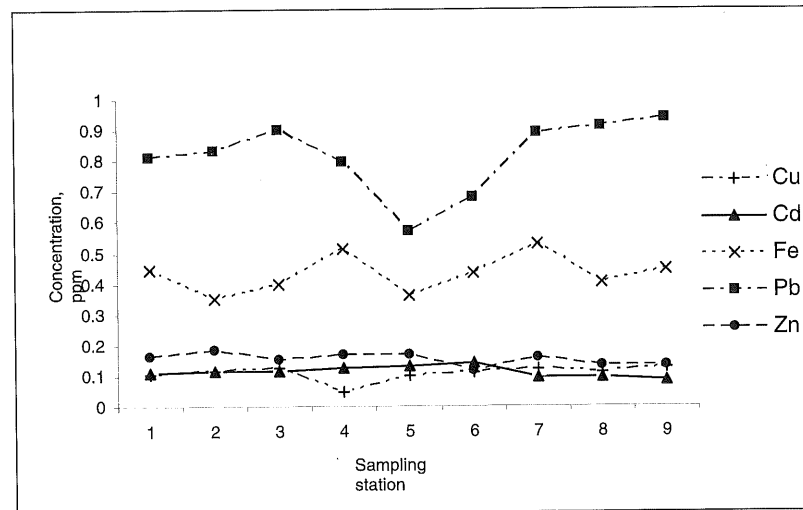
With exception for Cd, the average concentration of 0.112 ppm is approximately ten times above the permissible limit set by the Department of Environment.

Data from Table 1 and Graph 1 indicates that most of the elements showed little variation in concentration along the stretches of the rivers to the open sea. This relates that their distributions in the coastal area are not regulated by dilution with open seawater. The average pH of 7.47 and dissolved oxygen levels for all the stations showed little fluctuations (Graph 2). The concentrations of Cu, Cd, Fe, Pb and Zn showed negative correlations with salinity (Graph 3).

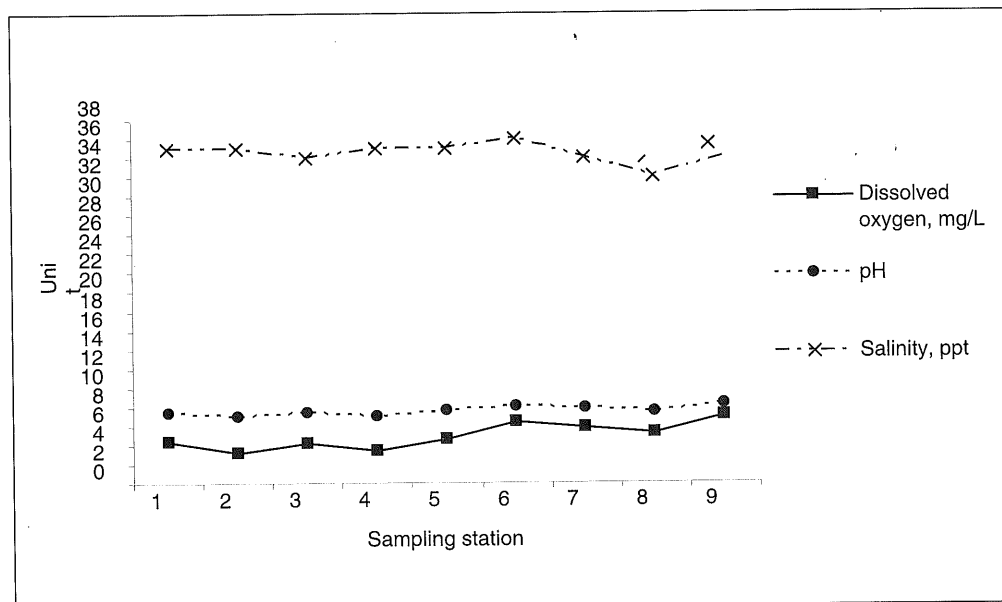
Table 1. Concentration of heavy metals found in the water samples collected at each station.

Elements Stations	Cu Conc./ppm	Cd Conc./ppm	Fe Conc./ppm	Pb Conc./ppm	Zn Conc./ppm
1	0.105	0.110	* 0.445	0.810	0.160
2	0.115	0.115	0.350	0.835	0.185
3	0.125	0.115	0.400	0.900	0.150
4	0.045	0.125	0.515	0.795	0.165
5	0.100	0.130	0.360	0.570	0.165
6	0.110	0.140	0.435	0.680	0.155
7	0.120	0.095	0.530	0.890	0.155
8	0.110	0.095	0.405	0.910	0.130
9	0.125	0.085	0.445	0.935	0.130

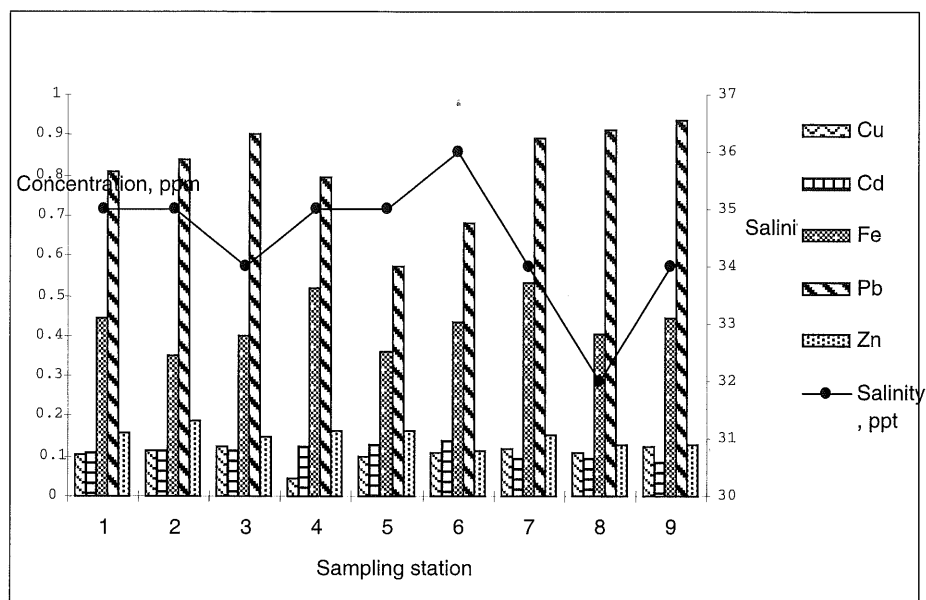
*ppm – parts per million



Graph 2. A graph of concentration of heavy metals *versus* sampling stations



Graph 3. Distribution level of dissolved oxygen, pH and salinity for each sampling station



Graph 4. Comparison level of salinity with concentration of metals for each sampling station

CONCLUSION

The results obtained from this preliminary study provide an approximate evaluation of the level of heavy metals found in the three rivers mentioned. Since most of the heavy metal elements under investigation showed low concentration and consistency in distribution along the stretches of the rivers to the open sea most probably indicates that it is of a naturally occurring source.

Metals that are naturally introduced into the river come primarily from such sources as rock weathering, soil erosion, or the dissolution of water-soluble salts. Naturally occurring metals move through aquatic environments independently of human activities, usually without any detrimental effects [4]. Mangrove sediments are normally rich in sulphide due to its anaerobic nature often provide a natural platform for the retention of water-borne heavy metals [5].

Conclusion from this study indicates that the levels of dissolved heavy metals of Cu, Fe, Pb and Zn were found to be within acceptable limit. The source of the unusually high level of Cd detected cannot be concluded at this stage but definitely deserved a more rigorous investigation

since Cd is quite toxic and has a potential of causing the most deleterious effects.

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