

DISTRIBUTION OF DISSOLVED AND PARTICULATE TRACE
METALS IN TERENGGANU RIVER ESTUARY

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DISTRIBUTION OF DISSOLVED AND PARTICULATE TRACE
METALS IN TERENGGANU RIVER ESTUARY

Dedication to

WILLIAM WONG HOE TECK

Thesis Submitted in Fulfillment of the Requirement for the Degree of Master of
Science in Institute of Oceanography
Universiti Malaysia Terengganu

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Work of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfillment of the requirements for the Degree of Master of Science

DISTRIBUTION OF DISSOLVED AND PARTICULATE TRACE METALS IN TERENGGANU RIVER ESTUARY

WILLIAM WONG BOE TECK

MARCH 2008

Chairperson : Prof. Dr. Noor Azhar Bin Mohd. Shauki, Ph.D.

Member : Assoc. Prof. Dr. Kadarnazaman Bin Hj. Yusoff, Ph.D.

Faculty : Institute of Oceanography

Dedication to

*Wong Nam Chu, Chin Fook Koon,
Sally Wong, Shiau Nee and Shiau Juan*

The distribution of dissolved and particulate trace metals in the Terengganu River estuary was studied in four surveys in 2005 and 2006. The concentration of particulate Cr, Cu, Zn, Cd and Pb were in the range of 2.76µg/g - 133.58µg/g, 0.49µg/g - 20.64µg/g, 1.38µg/g - 57.38µg/g, 0.29µg/g - 187.95µg/g, 0.06µg/g - 1.59µg/g, and 2.59µg/g - 74.77µg/g, respectively. Concentration of particulate trace metals declined seawards indicating that the source of the metals are from the river. In addition, the concentration of particulates was inversely related with salinity especially in the second sampling period, again suggesting river derived particulate trace metals. The concentrations of particulate trace metals also showed inverse relationship with TSS. The concentrations of dissolved Cu, Pb, Cd, Zn, Cr and Ni were in the range of 0.0002µg/L - 0.0432µg/L, 0.0001µg/L - 0.0007µg/L, 0.0001µg/L - 0.0007µg/L, 0.0001µg/L - 0.0007µg/L, 0.0001µg/L - 0.0007µg/L and 0.0001µg/L - 0.0007µg/L, respectively. Most of the total dissolved trace metals showed

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The distribution of trace metals Cr, Co, Cu, Cd, Pb and Zn between dissolved (total dissolved and C18 extractable) and suspended particulate matter (SPM) in the Terengganu River estuary was studied in four surveys in 2005 and 2006. The concentration of particulate Cr, Co, Cu, Zn, Cd and Pb were in the range of 2.76 $\mu\text{g/g}$ - 125.58 $\mu\text{g/g}$, 0.49 $\mu\text{g/g}$ - 20.64 $\mu\text{g/g}$, 1.38 $\mu\text{g/g}$ - 57.58 $\mu\text{g/g}$, 0.29 $\mu\text{g/g}$ - 183.95 $\mu\text{g/g}$, 0.06 $\mu\text{g/g}$ - 1.56 $\mu\text{g/g}$, and 2.56 $\mu\text{g/g}$ - 78.73 $\mu\text{g/g}$, respectively. Concentrations of particulate trace metals declined seawards indicating that the sources of the metals are from the river. In addition, the concentration of particulates was inversely related with salinity especially in the second sampling period, again suggesting river-derived particulate trace metals. The concentrations of particulate trace metals also showed inverse relationship with SPM. The concentrations of total dissolved Cr, Co, Cu, Zn, Cd and Pb were in the range of 0.0958 $\mu\text{g/L}$ - 0.5432 $\mu\text{g/L}$, 0.0178 $\mu\text{g/L}$ - 0.6507 $\mu\text{g/L}$, 0.0430 $\mu\text{g/L}$ - 0.5665 $\mu\text{g/L}$, 0.0441 $\mu\text{g/L}$ - 8.8500 $\mu\text{g/L}$, B.D.L. - 0.1182 $\mu\text{g/L}$ and B.D.L. - 1.2134 $\mu\text{g/L}$, respectively. Most of the total dissolved trace metals showed

increase with increasing salinity in the first and second sampling periods. Meanwhile, the concentrations of C18 extractable Cr, Co, Cu, Zn, Cd and Pb were in the range of B.D.L - 0.2614 $\mu\text{g/L}$, B.D.L. - 0.0121 $\mu\text{g/L}$, B.D.L. - 0.2738 $\mu\text{g/L}$, B.D.L. - 2.9664 $\mu\text{g/L}$ and B.D.L. - 0.3687 $\mu\text{g/L}$, respectively. The presence of high proportion of some of the metals in the C18 extractable form suggests that ligands binding with these metals are to some extent metal specific. Accordingly, the role of hydrophobic phase in transport of dissolved of Cd transport appears to be negligible. The concentrations of total dissolved trace metals and C18 extractable trace metals showed a decrease in the fourth sampling, which was probably due to the dilution by heavy rainfall during the North-east Monsoon season. The partition coefficient of Cr, Cu and Cd between dissolved and particulate declined with increasing SPM in the second sampling period. This inverse dependency may be explained by the "particle concentration effect", which can be caused by the presence of fine particles (including colloids) enriched with those metals at low SPM concentrations and salinity induced desorption from particulates. The order of $\log K_{ds}$ found in the study area was $\text{Cr} > \text{Pb} > \text{Cu} > \text{Co} > \text{Zn} > \text{Cd}$. Dissolved phase is the major carrier for Co, Cd, Cu and Zn, while Cr and Pb are mainly transported in the particulate phase.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu
sebagai memenuhi keperluan untuk Ijazah Master Sains

TABURAN LOGAM-LOGAM SURIH TERLARUT DAN PARTIKULAT DALAM MUARA SUNGAI TERENGGANU

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Taburan logam surih Cr, Co, Cu, Cd, Pb dan Zn di antara logam terlarut (jumlah logam terlarut jumlah dan CI8 terekstrak) dan logam partikulat di muara Sungai Terengganu telah dikaji dalam empat survei pada tahun 2005 dan 2006. Kepekatan partikulat Cr, Co, Cu, Zn, Cd dan Pb berada dalam julat 2.76 μ g/g -125.58 μ g/g, 0.49 μ g/g - 20.64 μ g/g, 1.38 μ g/g - 57.58 μ g/g, 0.29 μ g/g - 183.95 μ g/g, 0.06 μ g/g - 1.56 μ g/g dan 2.56 μ g/g - 78.73 μ g/g masing-masingnya. Kepekatan logam surih partikulat menunjukkan penurunan menghalu ke laut. Ini menunjukkan logam partikulat berasal dari sungai. Tambahan pula, kepekatan partikulat menunjukkan hubungan yang bersongsangan dengan kemasinan, terutamanya pada penyampelan kedua, dan ini sekali lagi mencadangkan bahawa logam partikulat berasal dari sungai. Kepekatan logam surih partikulat juga mempamerkan hubungan yang bersongsangan dengan SPM. Kepekatan logam surih terlarut jumlah bagi Cr, Co, Cu, Zn, Cd and Pb berada dalam julat 0.0958 μ g/L - 0.5432 μ g/L, 0.0178 μ g/L - 0.6507 μ g/L, 0.0430 μ g/L - 0.5665 μ g/L, 0.0441 μ g/L - 8.8500 μ g/L, B.H.K. (Bawah

Had Kesan) - 0.1182 $\mu\text{g/L}$ dan B.H.K.. - 1.2134 $\mu\text{g/L}$ masing-masingnya. Kebanyakan logam surih terlarut jumlah adalah berkadar terus dengan kemasinan pada penyampelan pertama dan kedua. Manakala kepekatan bagi logam C18 terekstrak Cr, Co, Cu, Zn, Cd and Pb berada dalam julat B.H.K. - 0.2614 $\mu\text{g/L}$, B.H.K. - 0.0121 $\mu\text{g/L}$, B.H.K. - 0.2738 $\mu\text{g/L}$, B.H.K. -2.9664 $\mu\text{g/L}$ dan B.H.K. - 0.3687 $\mu\text{g/L}$ masing-masingnya. Nisbah beberapa logam dalam bentuk C18 terekstrak yang tinggi mencadangkan penambatan ligan dengan logam tersebut adalah khusus kepada sesetengah logam itu. Oleh itu, peranan fasa hidrofobik di dalam pengangkutan Cd terlarut adalah sangat sedikit. Kepekatan jumlah logam surih terlarut dan logam surih C18 terekstrak mempamerkan susutan pada penyampelan kali keempat. Ini disebabkan pencairan daripada hujan lebat pada musim monsun Timur Laut. Pekali sekatan bagi Cr, Cu dan Cd antara fasa terlarut dan partikulat adalah berkadar songsang dengan SPM semasa penyampelan kedua. Hubungan songsangan ini boleh diterangkan dengan "Kesan Kepekatan Partikel" (PCE) di mana mungkin dipengaruhi oleh kewujudan partikel halus (termasuk kolloid) yang kaya dengan logam-logam semasa kepekatan SPM yang rendah dan penyerapan daripada partikulat dibawah pengaruh kemasinan. Tertib untuk $\log K_d$ yang didapati di kawasan kajian adalah $\text{Cr} > \text{Pb} > \text{Cu} > \text{Co} > \text{Zn} > \text{Cd}$. Fasa terlarut merupakan pembawa logam surih utama bagi Co, Cd, Cu dan Zn manakala Cr dan Pb adalah diangkut dalam fasa partikulat.