

# **Study on the Impact of Sediment Porewater Quality on the Benthic Infauna of the Mai Po Mudflats (Tender Ref. AFD/SQ/72/98)**

## **Executive Summary**

- 1.1 Sediment and porewater quality of the Mai Po Mudflats has been thoroughly studied over a period of ten months (from March 1999 to January 2000). Vertical profiles (0 to -35 cm) of trace metals (Cd, Cr, Cu, Pb and Zn) and trace organic pollutants (fifteen priority PAH compounds, petroleum hydrocarbons, twelve commonly used organochlorine pesticides and total PCBs) at eight sampling stations (TA1 - TA5, TB3 - TB5) distributed over the mudflats have been determined. Novel analytical techniques such as polyacrylamide gel sampler for porewater trace metal profiling and semipermeable membrane devices (SPMD) sampler for porewater trace organics profiling were employed.
  
- 1.2 Except [Cd], levels of heavy metals in the mudflat sediment are generally comparable to those in Deep Bay. This implies that both areas may be affected by similar point and non-point heavy metal pollution sources. On the other hand, level of sedimentary [Cd] on the mudflats is high (nearly two-fold higher) compared to Deep Bay. Enrichment of dissolved heavy metals in sediment porewater of the mudflats is generally observed. Hotspots of heavy metal pollution were found on the edge of the Mai Po mangroves and in regions near mouths of Shenzhen River and Shan Pui River. Among the five

heavy metals, [Cd] has shown the greatest tendency of remobilization from the sediment phase to the more bio-available porewater phase.

1.3 The porewater heavy metal analysis reveals retardation of sediment diagenetic reactions in winter, causing lowering of levels of trace metals in sediment porewater during winter. The low ambient temperature on the mudflats is most probably the cause. This finding suggests that heavy metal toxicity in the local ecosystem vary throughout the year: higher in summer and lower in winter.

1.4 Comparing to statutory sediment and marine water quality criteria of various local and international authorities (e.g. HK-EPD, USEPA, ASEAN, NOAA, the Canadian standards and the Netherland's standards) for trace metals, sediments of the Mai Po Mudflats is not considered heavily polluted. The only significant exceedance was the abnormally high sediment [Cu] concentration in the winter survey. The cause of such high [Cu] concentration in the study period is not fully understood. On the other hand, quality of the sediment porewater of the mudflat is alarming. Levels of all the five trace metals studied were found to breach USEPA acute criteria for marine waters in summer. From their extent of remobilization and non-compliance to statutory limits, [Cd], [Cu] and [Zn] are considered the three most important trace metal pollutants. Referring to available literatures on eco-toxicities of these metals, their concentrations are already high enough to pose substantial stresses to the local benthic infauna.

- 1.5 PAH pollution in the Mai Po Mudflats is found to be serious. At the most polluted region (central part of the mudflat), levels of PAHs are comparable to heavily polluted sites in urban coastal areas such as Kwun Tong and Tsing Yi. Moreover, significant proportions of PAHs in the Mai Po Mudflats are heavier PAH compounds, which are generally considered to be more carcinogenic. Thus, sediment quality of the Mai Po Mudflats in terms of PAH pollution may be even worse than that of Kwun Tong and Tsing Yi. However, when compared to sediment quality guidelines established by individual researches and by various international authorities (e.g. USEPA, the Dutch standards, the Canadian standards, OSPAR, etc.), the present levels of PAHs in the mudflat sediment are not considered high. Only few isolated cases of exceedances of threshold levels were observed.
- 1.6 Petroleum hydrocarbon pollution in the Mai Po Mudflats is also found to be serious. Sedimentary contents of total petroleum hydrocarbons are 2 to 3 times higher than those measured at Tsim Bei Tsui. This indicates that sources of petroleum hydrocarbon pollution of the Mai Po Mudflats are not from the Inner Deep Bay, but probably from the Shenzhen River. The UCM to *n*-alkanes ratio indicates that petroleum hydrocarbon pollution of the Mai Po Mudflats is most likely caused by the discharge of petroleum related compounds.
- 1.7 Pollution of the mudflats by organochlorine pesticides and PCB is relatively moderate. Their levels in the Mai Po Mudflats were comparable to the Deep Bay and other coastal regions of south China.

- 1.8 From available literatures on eco-toxicities of PAHs, PCBs and organochlorine pesticides, benthic polychaetes appear to possess relatively high tolerance (up to ppm level) to these organic pollutants. The present levels of PAHs, PCBs and organochlorine pesticides (all in ppb level) seem not able to pose significant stress to the local benthic polychaete communities. However, as other benthic organisms are generally not as tolerable as polychaetes, it is less certain whether the present levels of these trace organic pollutants are threatening other local benthic infauna. Also, as effects of many other external factors, e.g. high ambient temperature and high solar irradiance, of the mudflat on the eco-toxicity of these pollutants are not fully understood, their actual impacts to the local ecosystem should not be underestimated.
- 1.9 In conclusion, the present study shows that sediment and porewater quality of the Mai Po Mudflats are mostly affected by high levels of trace metals, PAHs and petroleum hydrocarbons. When impact on benthic infauna, especially polychaetes, is concerned, trace metal pollution ([Cd], Cu and [Zn] in particular) seems to be more important. Despite the knowledge that have been obtained on the background levels of anthropogenic contaminants in the Mai Po Mudflats, a number of important links to the establishment of a sound and reliable risk assessment for the entire Mai Po ecosystem are still not available. The following is a list of recommendations to the authority on works and studies that are needed to undertake in order to assess the risk

faced by the wetland ecosystem as a whole as well as to ensure proper conservation of the Mai Po region:

- a) To determine loadings of trace metals ([Cd], [Cr], [Cu], [Hg], [Ni], [Pb] and [Zn]) and trace organic contaminants (PAHs, total PCBs, organochlorine pesticides and petroleum hydrocarbons) in tissues of local Mai Po organisms, especially those that are food sources of local and migratory birds, e.g. benthic polychaetes, mudskippers, crabs and fishes in the Mai Po Mudflats and fishes in the surrounding Mai Po *gei wei*.
- b) To determine loadings of trace metals and trace organic contaminants in tissues (feathers, muscle and internal organs) of local and migratory birds and bird eggs and to estimate the bioaccumulation factors for different contaminants.
- c) To study the ecotoxicological effects of trace metals and trace organic contaminants on local benthic infauna species.
- d) To identify the sources of trace metals and trace organic contaminants in the Mai Po ecosystem.
- e) To monitor the levels of trace metals and trace organic contaminants in the sediment and porewaters phases of the Mai Po environment at a regular basis.

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