Polynuclear Aromatic Hydrocarbon (PAHs) in the Thai/Laos Mekong River, 2000-2003

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Abstract

Seasonal monitoring of 10 sampling stations along Thai/Laos Mekong River both water and sediment samples from Golden triangle, Chiang Rai to Kongchiam, Ubon Ratchathani were analysed. Qualitative and quantitative analysis of the 16 priority PAHs namely, naphthalene, acenaphthylene, fluoranthrene, pyrene,benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene and indeno(1,2,3,cd)pyrene were determined by EPA 8310 method using HPLC-DAD. Total PAHs were measured by fluorescence chrysene equivalents. The results show that the total amount of PAHs in the surface water and sediments were in the range of 1.1-2.8 ppb and 25-280 ppb respectively.

Introduction

PAHs are ubiquitous pollutants in environment, consisting of two or more fused benzene rings in linear, angular or cluster arrangement. PAHs in the atmosphere can be polluted in many kinds of environmental sample such as soil, rain, river etc., which many are known to be carcinogenic agents. The toxicity of the PAHs in environment depends on the types and quantity of each PAHs. The aim of this report is to examine the spatial distribution and seasonal variation of the PAHs in the Mekong River, Thailand from 2000-2003.

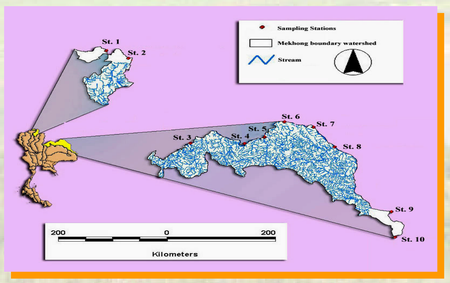

Figure 1 Map shows the locations of the sampling stations along the Mekong River.

Materials and methods

Analysis of PAHs by Spectrofluorometry

Sediment: Weighed quantities (~0.2 g) of air-dried sediment were placed in a plastic universal container with 20 ml of hexane and extracted for 50 minutes in an ultrasonic bath. The resulting extract was centrifuged to remove suspended particulates. The fluorescence of diluted solution (EM = 360 nm, EX = 310 nm) was determined and compared with the fluorescence of standard chrysene solutions (UNEP, 1992).

Water: 500 ml of water from the Mekong River was passed successively through activated SPE-C18 column with a flow rate of 2 ml/min. The column was then eluted with hexane with a flow of 1 ml/min. The fluorescence of diluted solution was determined and compared with standard chrysene solutions.

Analysis of PAHs by HPLC

Sediment: The extraction method was the same as the analysis by spectrofluorometry. The extract was evaporated to dryness in a rotary evaporator at 20-30 °C and the residue was transferred quantitatively into a volumetric flask using acetonitrile. Analysis of 16 PAHs in the extracts were performed by HPLC-DAD (EPA 8310) using the standard addition method.

Water: The extraction method was the same as the analysis by spectrofluorometry. The extract was analyzed for 16 PAHs using the same procedure as described in the previous section.

Analysis of combustible material in sediment

Combustible material was determined by the loss of weight incurred when a sample of sediment was heated to 900 °C and maintained at this temperature for 1 hour.

Results and Discussion

Water: The total PAHs concentrations (µg of chrysene equivalent per litre) observed in surface water ranged from 1.1-2.8 µg/L (ppb) as shown in Figure 2. It shows that Mekong water is quite clean to compared surface water in Antarctica, 0.15-4.65 µg/L (Weber and Bicego, 1987).

Figure 2 Total PAHs concentration in surface water (µg/L)

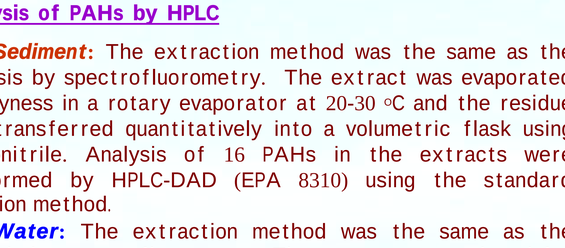

Figure 3 Seasonal variation of PAHs in water from different stations along the Mekong River (mg/kg)

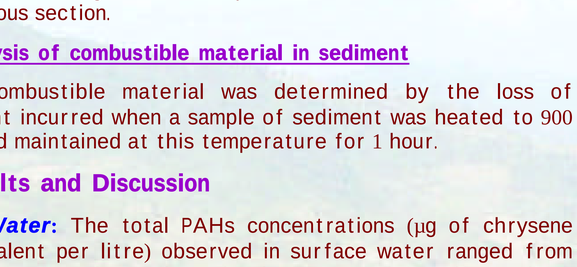

Figure 4 Average PAHs of all seasons in water from different stations along the Mekong River (mg/kg)

Sediment: The average weight loss (all locations) when the sediments were combusted shown in Table 1. This demonstrates that 90-97% of the sediments consisted of minerals and only 3-10% consisted roughly of organic matter. If the PAHs are in the organic portion, the organic portion is polluted and this needs further investigation.

Table 1 Average weight loss on combustion (900 °C) (% dry weight)

December 2001	April 2002	August 2002	April 2003
5.5±0.7	2.9±0.4	9.0±0.6	3.2±0.4

The total PAHs concentrations (µg chrysene equivalent per gram dry weight) in the sediments shown in Figure 5-7 show some sediments containing more than 0.5 µg/g of PAHs that are polluted (Yilmaz et al., 1998). The concentration appeared to be seasonal variation associated mainly with the rains and the temperature.

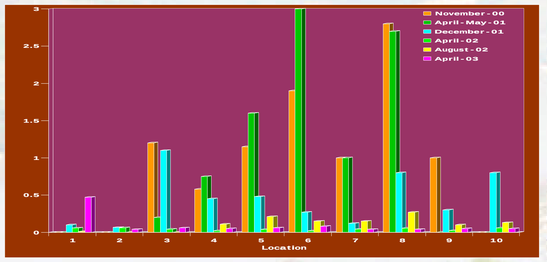

Figure 5 Total PAHs concentration in sediments (µg/g dry weight)

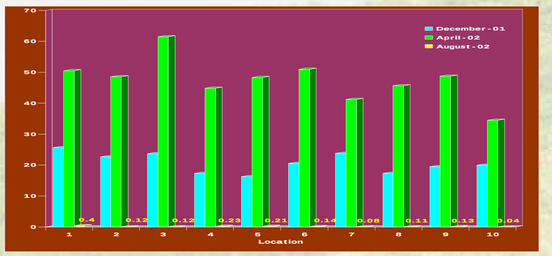

Figure 6 Seasonal variation of PAHs in sediment from different stations along the Mekong River (mg/kg)

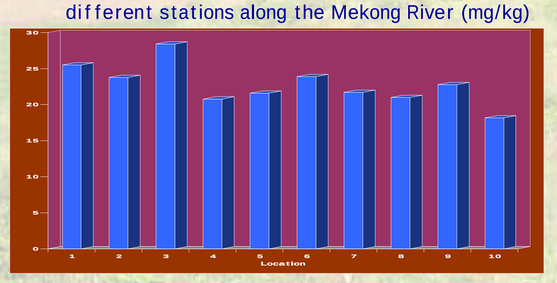

Figure 7 Average PAHs of all seasons in sediment from different stations along the Mekong River (mg/kg)

Figure 8 shows a typical HPLC distribution of the individual PAHs in the sediments. This distribution varies little with either season or location. Then the PAHs appear to have a common source.

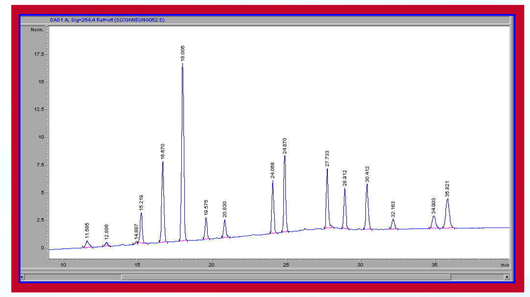

Figure 8 Standard chromatogram of 16 PAHs

Table 2 PAHs result of sediment St.1, St.3 and St.9 (April 2003) by HPLC (concentration in ppb)

PAHs	Station 1		Station 3		Station 9	
	Water	Sediment	Water	Sediment	Water	Sediment
Naphthalene	1.60	32.04	0.21	82.95	0.019	44.24
Acenaphthrene	BDL	BDL	BDL	BDL	BDL	BDL
Acenaphthylene	BDL	BDL	BDL	BDL	BDL	BDL
Fluorene	BDL	BDL	0.40	46.19	2.20	8.25
Phenanthrene	0.36	65.63	0.08	95.60	0.04	100.01
Anthracene	0.36	25.90	0.27	44.89	0.07	67.02
Fluoranthene	1.91	95.19	0.19	84.63	0.46	119.99
Pyrene	1.04	163.27	BDL	BDL	BDL	20.55
Benzo(a)anthracene	BDL	BDL	BDL	BDL	BDL	6.35
Chrysene	2.25	19.31	0.46	2.90	0.07	18.95
Benzo(b)fluoranthene	1.56	35.53	0.551	26.27	BDL	BDL
Benzo(k)fluoranthene	1.56	39.50	BDL	BDL	0.28	33.09
Benzo(a)pyrene	1.70	33.59	0.26	3.50	BDL	15.67
Dibenzo(a,h)anthracene	BDL	BDL	0.06	32.20	BDL	89.88
Benzo(ghi)perylene	1.89	131.63	BDL	43.78	0.16	141.70
Indeno(1,2,3-cd)pyrene	BDL	BDL	0.14	3.45	BDL	BDL

The results shows in Table 2 indicate the relatively high concentration of aromatic compounds with 3-4 rings i.e. pyrene, phenanthene, benzo(a)anthracene, chrysene and anthracene. However, the observed presence of carcinogenic PAHs (5-6 rings) i.e. benzo(b)fluoranthene, benzo(k)fluoranthene,benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene and indeno(1,2,3,cd)pyrene. in St.1, St.3 and St.9 may also observed.

Conclusions

This work shows the distribution of PAHs in water and sediments at various locations and seasons. It seems that there is a seasonal variation associated with rains and temperature. The results show that the total amount of PAHs in the surface water and sediment were in the range of 1.1 - 2.8 ppb and 25 - 280 ppb respectively. Although the PAHs concentration is low but it does not taken into account the bioaccumulation factor which range from 69 – 29000 for the PAHs analyzed.

References

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Acknowledgements

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