Using Polycyclic Aromatic Hydrocarbons (PAHs) as a Tracer to Estimate Terrestrial Pollutant Flux in Enjen River Sediment, Taiwan

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Introduction: Sediments are an integral part of the aquatic ecosystem. Persistent pollutants will adsorb onto sediment particles which could be re-suspended and accumulated in seafood through food chain. The subtropical climate of Taiwan, with an average of four typhoons per year and mean annual precipitation of 2.5 m yr^{-1}, combined with frequent earthquakes, together drive rapid mass-wasting and fluvial bedrock incision[1]. According to Dadson et al. (2003), total exported sediment amount is around 380 MT yr^{-1} in Taiwan, during 1979-1999. Highly throughput of river sediments will be temporarily settled in the river estuary and further to coastal area. In order to estimate how much of terrestrial pollutants were transported to coastal area, a river, Erjen river, densely polluted for decades in western Taiwan was chosen for analyzing persistent organic pollutants (POPs). The results could be used as an implication for decision-making in managing sediment quality with a mountainous river.

Methods: Sediments were sampled from 56 sites during dry season along Erjen river in late October, 2009. PAHs, PCBs and PCDD/Fs were analyzed with GC-MSD, GC-ECD and GC-HRMS, respectively. In additions, water samples were taken for analyzing PAH concentrations from July 2008 to July 2009 every month in order to determine PAH flux from Erjen river to coastal area. Quality of experiment was well controlled from our good performance with results of surrogates, spiked recoveries and duplicate samples.

Results: Our results showed that PCDD/Fs was found the highest at the Station 11 (464.7 ng I-TEQ kg^{-1} d.w.), which is three times higher than the Interim Sediment Removal Criteria in Japan. Concentrations of PAHs and PCBs in Erjen river ranged from 12.1 to 1460 and 0.45-591 (ng g^{-1} dw), respectively. Concentrations of dissolved and particulate PAHs ranged from 13.8 to 516 ng L^{-1} and from 4.05 to 55.9 ng L^{-1}, respectively(Fig. 1). In March (dry season), concentrations of dissolved and particulate PAHs ranged from 38.3 to 186 ng L^{-1} and from 4.05 to 25.9 ng L^{-1}, respectively. The highest total PAH concentration in this area was found in Station Er-3 which is located on a tributary of Er-Jen River.

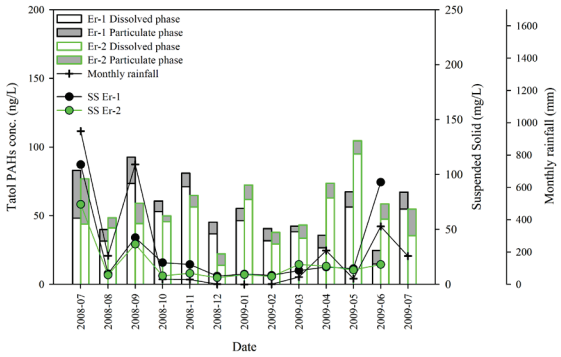

Fig. 2: Concentrations of dissolved and particulate PAHs Erjen river, Taiwan.

Discussion: Petrogenic and petroleum combustion origin were the main sources of PAHs in sediments of Er-ren River In addition, perylene was the most dominant compound in Er-ren River, suggesting that it could be a useful indicator to differentiate various PAH sources in sediments. The results of hierarchical cluster analysis (HCA) and principal components analysis (PCA) indicated that PAH groups were clustered based on the loading of perylene. According to the ΣESBTUFCV of PAHs and the toxic equivalents (TEQ) of PCBs were both lower than quality values reported, suggesting that adverse ecological effects might be not expected. The annual total PAH fluxes of Er-Jen River were estimated to be 23.1 kg For dissolved phase, the average daily fluxes in dry and wet season were 5.9 g day^{-1} and 65.8 $gday^{-1}$, respectively, with an annual mean fluxe of 11.3 kg yr^{-1}. For particulate phase, the mean daily fluxes in dry and wet season were 0.8 g day^{-1} and 76.2 g day^{-1}, respectively, with an annual mean flux of 11.8 kg yr^{-1}. In general, the total PAH fluxes in wet season were higher than dry season. The total annual PAH fluxes in Er-Jen River were generally less than those reported worldwide, and comparable to those in San Francisco River in USA[2], but higher than those in Le Havre River in France[3].

References: [1] Dadson et al. (2003) *Nature* **11**:111-122; [2] Greenfield, B.K. and Davis, J.A., (2005) *Chemosphere* **60**:515-530; [3] Motelay-Massei et al., (2006) *Water Research* **40** :1995-2006. ;[4] Fang et a l. (2012) *Journal of Environmental Management* **110** : 179-187.