RISK ASSESSMENT OF WASTEWATER TOXICITY FROM INDUSTRIAL PARKS IN SAIGON – DONGNAI RIVER BASIN

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Abstract

An approach combining a battery of small-scale toxicity tests with physico-chemical analysis was applied to investigate the selected 27 industrial parks along to Saigon-Dongnai river basin. The test battery included an acute toxicity test with the cladoceran *Ceriodaphnia cornuta* developed in previous work as well as two acute toxicity tests with the cladoceran *Daphnia magna* and the bioluminescent bacteria *Vibrio fischeri*. The battery was chosen because it offers attractive features of simplicity, sensitivity and cost-efficiency. Furthermore, *C. cornuta* is an indigenous tropical species which was initially isolated in the Sai Gon River. An important ecotoxicity of different industrial wastewaters was found, especially in the Vinh Loc industrial zone. The results show that Potential Ecotoxic Effects Probe (PEEP) are appropriate tools in combining ecotoxicity tests with physico-chemical analysis for the assessment of water quality as well as for following the effectiveness of industrial wastewater treatment systems. In conclusion, integrating bioassay responses and effluent flow via the PEEP concept is a cost-effective, sensitive, practical and relevant approach to investigate the toxic potential of point source pollution and to prioritize the threat for the receiving water biota.

Keywords: battery of small-scale toxicity test, PEEP, Sai Gon – Dong Nai river basin

1. Introduction

The industrial zones at Sai Gon – Dong Nai river basin has a great social and economic importance but the water body of this city receives many industrial, domestic and agricultural discharges. Direct entrance of pollutants into aquatic ecosystems via complex liquid industrial waste emissions continues to be an important area of concern because of the potentially serious consequences which ecotoxic inputs can have on receiving water biota. Ecotoxicological risk assessment starts being an issue in Viet Nam and it is important to dispose of a test system, which is appropriate for the typical Vietnamese conditions with a species being representative of the invertebrates living in these aquatic ecosystems. In this study, we conduct toxicity test in applying a battery of small-scale toxicity with *D. magna, C. cornuta* and *V. fischeri* for assessing ecological risk due to industrial wastewater. To our knowledge, there is very few ecotoxicity data related to this river basin is published.

2. Material and methods

Sampling

Twenty-seven industrial wastewater samples along the Saigon-Dongnai River were taken at discharge of industrial zone or outlet of correspond wastewater treatment plan as illustrated in Figure 1. For each site, four volumes of each 500 ml sample were taken at 15-minute intervals and then made a composite sample. The composite samples were kept in plastic bottle at 4°C for transportation. After arrival at the laboratory, samples were stored at 2-4 °C and were analyzed within maximum 2 weeks.

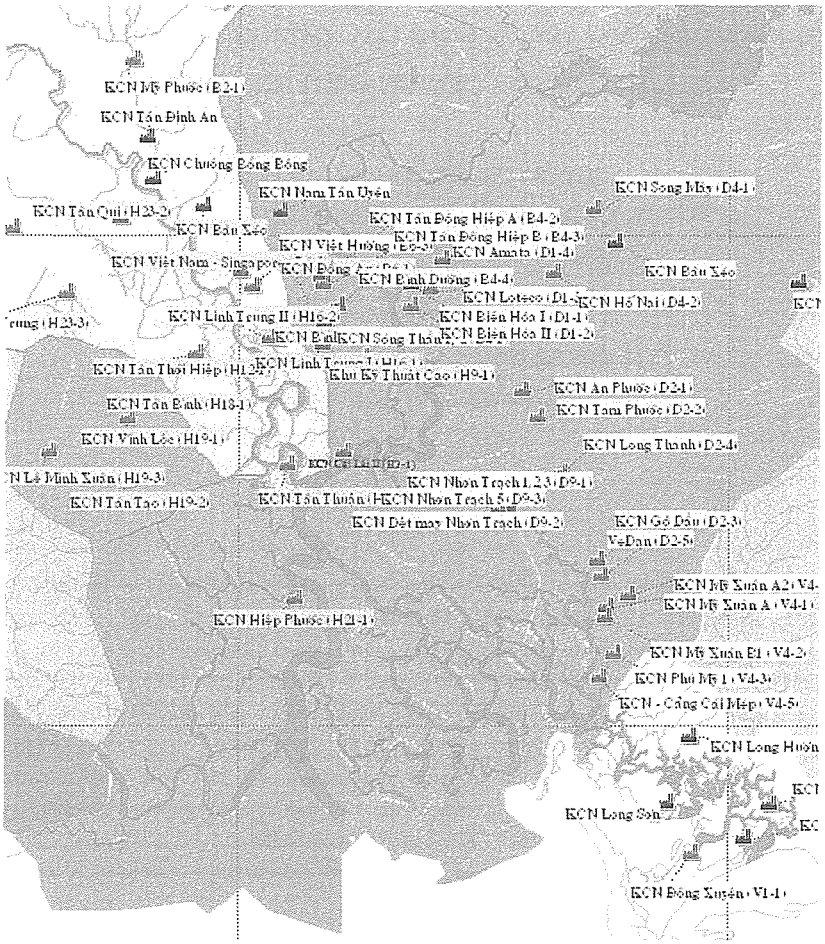

Fig.1 Sampling map

Toxicity test

V. fischeri

The toxicity of the sediment extracts was evaluated with the marine bacteria *V. fischeri* freeze dried bacteria obtained from Azur Environmental, USA using the Microtox analyzer 500 ISO, 1998. The concentration causing 50% inhibition of the light emitted by the bacteria 50% effective concentration EC was deter mined after 5, 15, and 30 min. The maximum DMSO concentration used for testing was 2%.

D. magna and C. cornuta

D. magna and *C. cornuta* or waterflea is a common microcrustacea in fresh water. The culture of *D. magna* Straus clone 1829 was maintained in an M4 medium Elendt, 1990. The test was performed according to the test protocol OECD 202 OECD, 1984, and the immobilization of the *D. magna* was recorded after 24 and 48 h. An International Organization for Standardization ISO medium ISO, 1989 was used during the test for the dilution of the sample and for the control. The maximum DMSO concentration used for testing was 0.1%.

PEEP index

The index of Potential Ecotoxic Effects Probe (PEEP) is to estimate potential ecotoxicity of industrial wastewater. In this study, PEEP index is calculated by following formula.

$$PEEP = \log_{10}\left[1 + n\left(\frac{\sum_{i}^{N} T_i}{N}\right)Q\right]$$

where

n : number of toxicity test

N : maximum of measured bio-response

T_i : toxicity unit of each toxicity test

Q : wastewater flow rate (m^3/h)

3. Results

Toxicity of industrial wastewater from 27-selected industrial zone is very various as showed in figure 2. Base on the threshold of TU from previous study (Do Hong et al., 2000), the following industrial zones showed a high toxicity to the tested organism are Hiepphuoc, Tantao, Tanbinh, Vinhloc, Tanthoihiep, Bienhoa I, Godau, Songthan, Phumy I. The wastewater from other industrial zones showed a low toxicity to tested organism was Tanthuan, Leminhxuan, Binhchieu, Taybaccuchi, Catlai2, Linhtrung1 & 2, VSIP, Viethuong.

The study found that industrial zones have their own wastewater treatment plan (WWTS) discharged less toxic materials to the river than the ones do not have WWST. The industrial zones have WWTP include Tanthuan, Linhtrung 1 & 2, Leminhxuan, VSIP and so on.

The results of PEEP index showed a variation from 0 to 5.4 in which Vinhloc industrial zone has no WWTP got the highest value (5.4) as illustrated in figure 3. The investigation carried out until begin of 2005 found discharge flow of 1,800 to 3,400 m^3/day correspond with PEEP from 4.3 to 4.7.

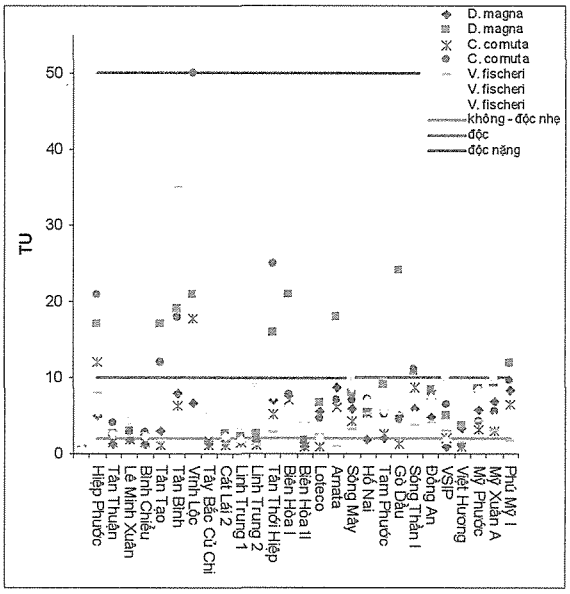

Fig. 2 Toxicity of industrial wastewater from selected industrial zones

Some of industrial zones have less or very few toxic to experimental organisms but high discharge flow rate such as Linhtrung 1& 2, Tanthuan have PEEP value varied from 3.3 to 3.6. The study found that discharge flow rate has influenced directly to toxic loading of wastewater and then to PEEP index. With the aim is to reduce toxic input of industrial wastewater to stabilize water quality of receiving sources, it is clear that the PEEP index of effluents of WWTP where highest toxic loading need to be decreased. In this case the concern industrial zones are Hiepphuoc, Tanbinh, Vinhloc, Tanthoihiep, Godau, PhumyI.

To get the target of reducing "toxic input", the PEEP index should be integrated as a executive tool of decision support system for integrated environmental management of the industrial zones along the Saigon – Dongnai river basin.

The authors have proposed to public authorities of provinces located in Saigon – Dongnai river basin the range of PEEP varies from 3 to 3.5 as a standard of effluent which to be less potential risk to the receiving ecology system. The application of this PEEP standard should be divided into two steps. The first step would be the improvement of WWTP to meet PEEP of 3.5 and the second step should be the implementation processes of cleaner production, zero emission, etc. so as to be meet PEEP of 3.

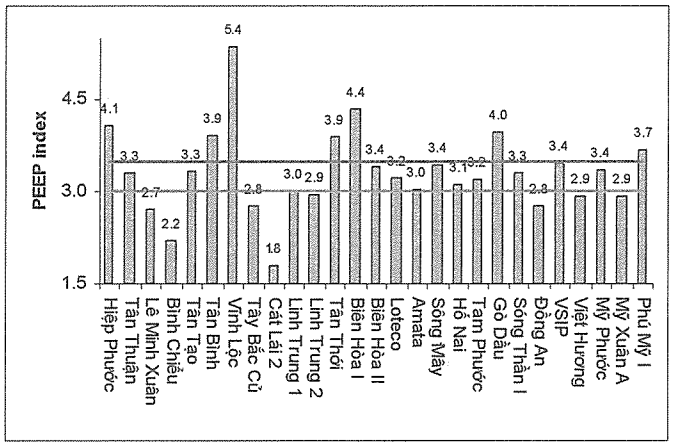

Fig.3 PEEP index of industrial wastewater from selected industrial zones

The study also showed that combination between ecotoxicity tests through bio-responses and analyses of bio-availability of chemical compositions could be a realistic and relevant approach to investigate and to assess the potential risk from a point sources that in this case is industrial wastewater. This approach permits to identify a problematic discharge of receiving water and to predict the ecological potential risk from these point sources.

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