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Baseline

Contamination of diuron in coastal waters around Malaysian Peninsular

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ABSTRACT

The use of antifouling paints to the boats and ships is one among the threats facing coastal resources including coral reefs in recent decades. This study reports the current contamination status of diuron and its behaviour in the coastal waters of Malaysia. The maximum concentration of diuron was 285 ng/L detected at Johor port. All samples from Redang and Bidong coral reef islands were contaminated with diuron. Temporal variation showed relatively high concentrations but no significant difference ($P > 0.05$) during November and January (North-East monsoon) in Klang ports (North, South and West), while higher levels of diuron were detected during April, 2012 (Inter monsoon) in Kemaman, and Johor port. Although no site has shown concentration above maximum permissible concentration (430 ng/L) as restricted by the Dutch Authorities, however, long term exposure studies for environmental relevance levels of diuron around coastal areas should be given a priority in the future.

In recent years, there has been an increasing attention on ecosystem health of coral reefs worldwide. It is indeed obvious that coral reefs have begun to face various threats due to global environmental changes, marine pollution, and biological survival competitions (Hughes et al., 2003). Most of the pollutants found in marine coastal waters of Malaysia are from animal and domestic wastes including sewage from coastal premises such as hotels and restaurants. Moreover, the presence of oil and grease in the coastal waters are from discharges by shipping vessels leakages and disposal of engine oils. The risk of chemical pollution of coastal areas near coral reefs needs to be given priority (Watanabe et al., 2006). In order to evaluate the impact of diuron in coral reefs it is important to know its status and behaviour in coastal and coral reef waters. Malaysia is the world's second largest palm oil producer (Ong and Goh, 2002). Previous studies show that pesticides such as diuron have played an important role in controlling and preventing pests and harmful plants and indirectly increase palm oil production (Sobhanzadeh et al., 2011).

Diuron, *N′*-(3,4-dichlorophenyl)-*N*, *N*-dimethylurea (DCMU) is a herbicide derived from urea. Diuron is predominately found in the dissolved phase and is weakly wept in sediments (Thomas et al., 2002). However, it is considered a priority hazardous substance by the European Commission (Malato et al., 2000). Some European countries such as UK, Sweden, Denmark, and France have restricted the use of diuron as antifouling paints in boats smaller than 25 m (Konstantinou and Albanis, 2004; Giacomazzi and Cochet, 2004). Diuron effects kills plants by blocking electron transport at photosystem II, thus inhibiting photosynthesis (Jones and Kerswell, 2003). Ecotoxicological studies show that, diuron causes significant impacts to the host and/or symbionts of corals (Jones, 2005).

Studies have demonstrated several effects of diuron on corals. For instance, the reduction of ^{14}C incorporation in *Madracis mirabilis* (Owen et al., 2003), the reduction of photosynthetic efficiency ($\Delta F/F'_m$) of *Stylophora pistillata*, *S. hystrix* and *Acropora Formosa*, (Jones and Heyward, 2003), the loss of symbiotic algae in *M. digitata* and *S. hystrix* (Jones, 2004), reduction the calcification rate of *G. fascicularis* (Sheikh et al., 2009) and the detachment of soft tissue of juvenile of *Acropora tenuis* (Watanabe et al., 2006). Certainly, detection of diuron in marine environments causes a number of ecological effects.

Despite extensive usage of diuron and related toxicological effects in corals, very little is known on its ambient levels and behaviour in marine environments around the Malaysian coast. This paper therefore provides results of a systematic monitoring study of diuron in the coastal areas including coral reef ecosystems around Malaysian Peninsular.

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Extensive survey of diuron in water around the coastal area of Malaysia was conducted during monsoon (November, 2011 and January, 2012) and dry season (April, 2012) from Kemaman, Klang and Johor ports. Total of 94 samples were collected in the entire sampling period. Among them, 10 samples were collected from coral reef Islands of Redang and Bidong situated at Terengganu in March, 2012 (Fig. 1). From each sampling station, 1 L sample of water was collected in an acetone-washed amber bottle. Sampling stick technique was used to collect the water at least 40 cm deep to avoid contaminated micro surface layer. In the laboratory, samples were stored at ~4 °C in cold and dark room and extracted within 10 days after the collection. Locations (GPS), data and characteristics of sampling sites are presented in Table 1.

Diuron from water samples was analysed following the solid phase extraction LC/MS–MS method as described by Sheikh et al. (2009). Briefly, water samples were pre-concentrated in the solid phase extraction cartridges column (PLS-3, GL sciences, Japan). Prior to the extraction of the diuron, the columns were conditioned with 10 mL of acetonitrile, followed by methanol and milli-Q water respectively. 10 mL of 0.2 M EDTA was added to 1 L of water and then pH of water was kept at 3.5. 1 mL of 1 mg/L diuron D-6 ($C_9H_4Cl_2D_6N_2O$) was spiked as a surrogate standard in order to monitor the recovery of diuron. Water samples were automatically eluted in the solid phase extraction column by using solid phase extraction controller (Shimadzu, Japan) with the flow rate of 20 mL/min. PLS-3 cartridges were then dried under nitrogen gas

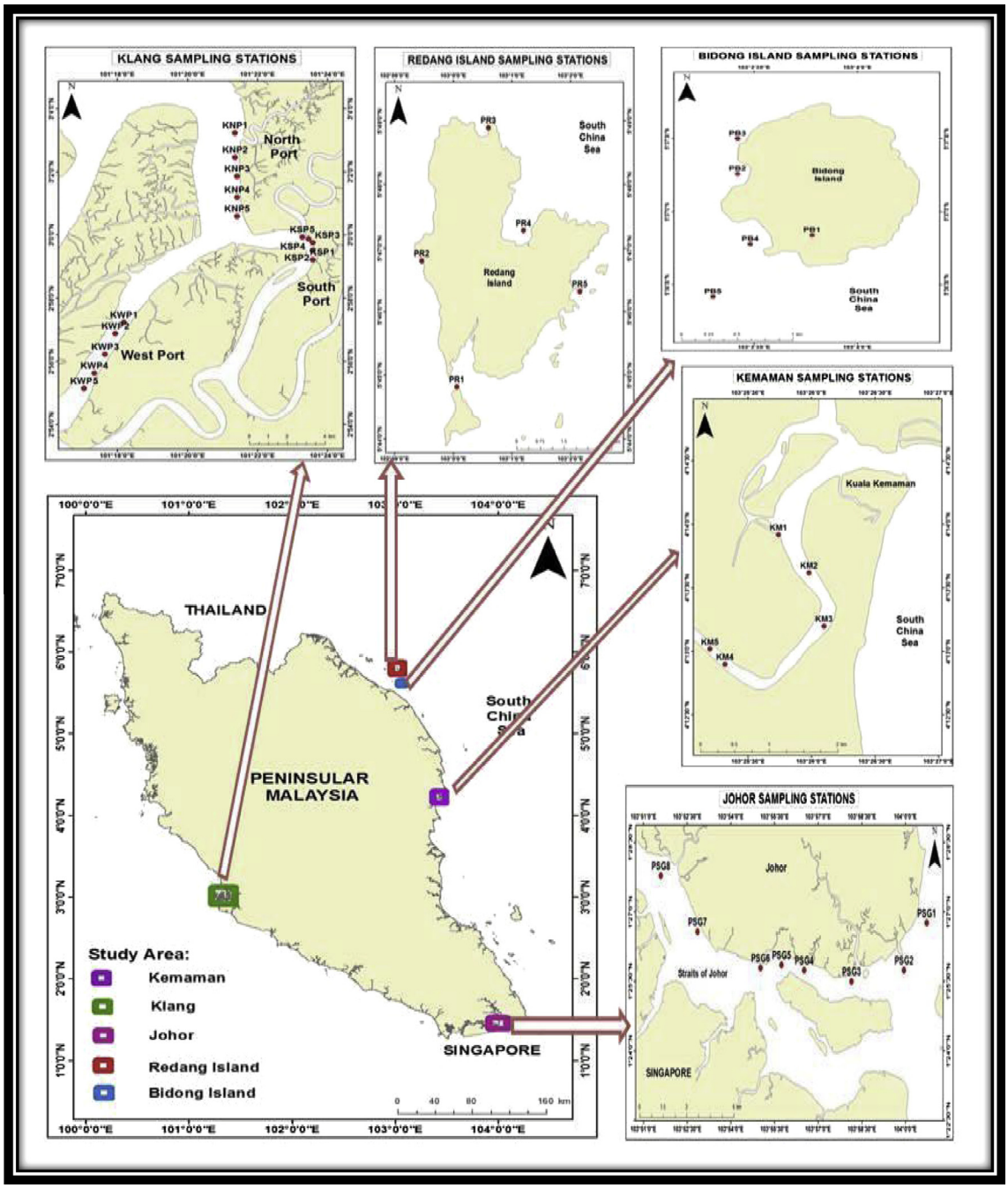

Fig. 1. Map of Malaysia showing location of sampling stations where PSG (1–8) are Pasir Gudang stations at Johor; KM (1–5) are Kemaman stations; PB (1–5) are Bidong Island stations; PR (1–5) are Redang Island stations; while KNP (1–5), KSP (1–5) and KWP (1–5) represents Klang Port stations for North, South and West respectively.