Phytoremediation of Illegally Dumped Petroleum Hydrocarbon-contaminated Wastewater Using Vetiver (Vetiveria zizanioides (L.) Nash)

T. Phenrat[1] and P. Teeratitayangkul [1]

[1]Department of Civil Engineering, Faculty of Engineering, Naresuan University, Thailand
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Presenting author email: pomphenrat@gmail.com

The community at the Nong-Nea subdistrict, Phanom Sarakham district, Chachoengsao province, Thailand, was suffered from illegal dumping of industrial wastewater containing high concentration of total petroleum hydrocarbon (TPH) (Figure 1a). To protect the Nong-Nea community's health and ecology, decreasing TPH exposure and migration is mandatory. Nong-Nea villagers need an effective, practical, sustainable remediation measure to reclaim their shallow groundwater and soil and to reduce the extent of the contamination. A remediation technique that allows community involvement will be of great benefit for Nong-Nea, which has an active environmentalist community.

(a) **(b)**

(c)

Figure 1 (a) Illegal dumping of TPH contaminated wastewater, (b) treatment of TPH contaminated water by vetiver on floating platforms in HDPE pond 1, and (c) treatment of TPH contaminated sediment by vetiver on landfarming in HDPE pond 2.

The phytoremediation of TPH by vetiver grass is a great remedial action candidate for the Nong-Nea incident. Phytoremediation is known for its cost effectiveness and ease of use. Thus, the Nong-Nea villagers can participate in the phytoremediation implementation. Most importantly, a recent study found that vetiver (Vetiveria

zizanioides (L.) Nash) can effectively treat illegally dumped phenol-contaminated wastewater (Phenrat et al, 2017). Here, we evaluated field scale implementation of using vetiver on a floating platform and as a land farming to treat TPH contaminated water and sediment, respectively.

The illegally dumped wastewater consists of two separable constituents, contaminated water and contaminated sediment. The sediment that settled at the bottom of the pond was much more contaminated than the water. The sediment contained very high concentration of hazardous total petroleum hydrocarbons (TPH) (130 mg/kg), while the water contained 296 mg/L of COD (the allowable COD is 120 mg/L), and 1,300 µg/L of hazardous total petroleum hydrocarbons (TPH) (the allowable TPH concentration in natural water is 300 µg/L). The contaminated water phase was first pumped from the illegal dumping pond to HDPE pond 1 while the settled sediment was excavated from the illegal dumping pond and placed into the HDPE pond 2. Vetiver on floating platforms were used to treat the water while landfarming of vetiver was used to treat the sediment.

For water treatment, a total of 21,600 vetivers were used to create 45 floating bamboo platforms for the treatment of the contaminated water in HDPE pond 1 (see Figure 1b). The vetivers in the floating bamboo platforms were a result of a voluntary collaborative effort between our field researchers and Nong-Nea villagers. Vetiver grass can also be used to treat COD and TPH in the contaminated water as suggested in literature (Brandt et al., 2006; Cook and Hesterberg, 2013). After, 30 and 56 days of treatment, COD decreased to 120 mg/L and 52.5 mg/L, respectively, while TPC became 215 and 161 µg/L after 28 and 42 days of treatment (see Figure 2a), respectively. This suggested that 45 floating vetiver platforms (21,600 plants) can treat COD and TPH in the 12 m x 23m x 2 m HDPE pond 1 (the total volume of 768 m^3) in around 1.5 months. The treated water was used for agricultural irrigation. For the sediment treatment, a total of 20,000 vetivers were used in the landfarming (Figure 1c). As shown in Figure 2b, TPH in the sediment was treated from 130 mg/kg to 40 mg/kg in 75 days.

To the author's knowledge, this is the first time that vetiver on floating platform and landfarming were used for field-scaled treatment of TPH-contaminated wastewater, especially for community prevention from hazardous constitutes from illegal dumping.

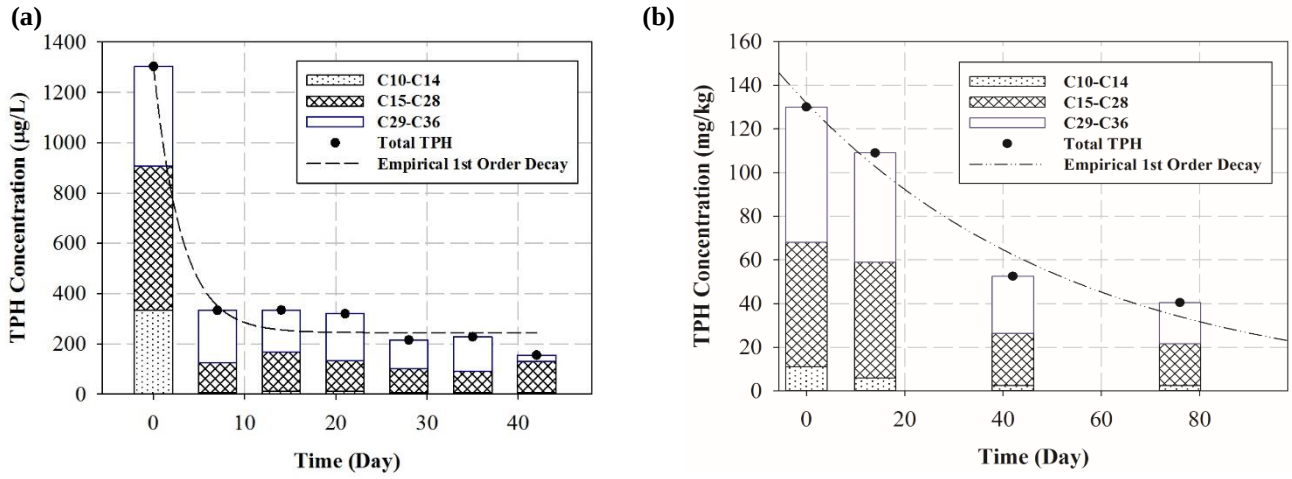

Figure 2 (a) Treatment of TPH contaminated water using vetiver on a floating platform and (b) treatment of TPH contaminated sediment using vetiver in a landfarming.

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